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This study was designed to investigate the effects of increasing levels of task complexity on the conditioned emotional response (CER) with human subjects (Ss). Three hypotheses were proposed: (1) the CER would increase as task complexity increased, (2) there would be sex differences between Ss with respect to the interaction between the CER and task complexity, and (3) the CER procedures would produce an increase in variability. Proceeding through three levels of task complexity (8-, 16-, and 32-stimulus tasks), a stable baseline of performance for each S was attained. Ss then received CER training which utilized a 2100 cycles per second tone as the conditioned stimulus and paired it with a "painful" level of shock. Each S was then administered a seven-question questionnaire and the Self Analysis Questionnaire. The dependent variables were rate of responding, stimulus presentation time, and response latency. Statistical analyses of group data did not support any of the three hypotheses. (Author/KP)

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CONDITIONED EMOTIONAL RESPONSE: PERFORMANCE DECREMENT IN HUMANS AS A FUNCTION OF TASK COMPLEXITY

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Tallahassee, Florida

March, 1969

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FOREWORD

This report is divided into two parts. The main study, The Conditioned Emotional Response With Humans As A Function of Task Complexity, deals with the Conditioned Emotional Response in college students. This research was accomplished as a Doctoral Dissertation.

A secondary study, Conditioned Anxiety Responses in Retarded Children, represents an attempt to apply a modification of the same procedure to mentally retarded children. Numerous methodological problems were encountered however, rendering the data less reliable than desireable. The study is reported to point out these problems for future research.

THE CONDITIONED EMOTIONAL RESPONSE WITH HUMANS AS A FUNCTION OF TASK COMPLEXITY

(Publication No.   )

David A. Sachs, Ph.D.
The Florida State University, 1968

The present study was designed to investigate the effects of increasing levels of task complexity on the conditioned emotional response (CER) with human Ss.

Three hypotheses were proposed. It was first hypothesized that the CER would increase as task complexity increased. Secondly, it was hypothesized that there would be sex differences between Ss with respect to the interaction between the CER and task complexity. Finally, it was hypothesized that the CER procedures would produce an increase in variability.

Three male and three female Ss participated in matching-to-sample tasks. Each S served as his own control for each of 3 levels of task complexity (8-, 16-, and 32-stimulus tasks). After obtaining a stable baseline level of performance on the 8-stimulus task, each S received 7 sessions of CER training. Conditioned emotional response training consisted of using a 2100 cps tone as the CS and pairing it with a "painful" level of shock (the UCS). The interstimulus interval was 45". After completing 7 CER sessions on the 8-stimulus task, Ss were trained to baseline on the 16-stimulus task. Following baseline, 7 CER sessions were conducted. The same procedures were followed for the 32-stimulus task. Upon completing the 32-stimulus task, each S was administered a 7-question questionnaire to determine how he reacted to the experimental procedures, and the Self Analysis Questionnaire to allow for estimation of his predisposition to manifest anxiety.

The dependent variables were rate of responding, stimulus presentation time (time between making a response and presenting the next stimulus), and response latency (time between presenting a stimulus and making a response).

Statistical analyses of group data did not support the hypothesis that the CER would increase as task complexity increased. Visual analysis of the performance of individual Ss, when presented in figures, using both means and suppression ratios, indicated that if a S demonstrated the CER, the magnitude of the CER increased as task complexity increased. This relationship was observed to be more visible for response rate and response latency than for stimulus

presentation time.

Statistical analyses of group data did not support the hypothesis that there would be significant sex differences with respect to the interaction between complexity and the CER. The results of these analyses did imply that there was a significant sex difference with respect to the effect of CER procedures, but this was not related to task complexity.

There was no support for the hypothesis that CER procedures affected response variability.

Data were presented which indicated that the effects of the CS on responding was maximal following CS onset and preceding UCS onset.

A significant correlation was obtained between Ss' scores on the A-trait scale of the Self Analysis Questionnaire and the Ss' rankings on performance decrement. The correlation between Ss' rankings on the A-state scale was not significant.

INTRODUCTION

Contemporary psychological literature has tended to view "anxiety," "stress," and "emotion" as slightly related and unclearly distinguished phenomena. These terms have often been used interchangeably with reference to the presence of internal organismic conditions.

Although these terms are no more than constructs inferred from behavioral or physiological indices, many authors have tended to speak of anxiety or stress as if the construct was in fact a measurable entity that was independent of behavior (Taylor and Spence, 1952; Sarason and Palola, 1960; Shepard and Abbey, 1958; Johnston and Cross, 1962; Brown, 1966).

Brady (1962) has taken the position that relevant emotional processes must be identified in terms of their operationally defined behavioral characteristics and such descriptions must be described independently of their concomitant physiological events. The meaning of this position for research in the area of anxiety is clear: to study anxiety one should define this construct in procedural and behavioral terms.

Although psychological journals contain many studies examining the effects of "anxiety" and "stress" on various behaviors, the majority of the literature has defined anxiety independently of the behavior being investigated. The present study is designed to investigate the effects of task complexity on the conditioned emotional response (CER). On the basis of current literature, the CER is considered to be a behavioral index that is indicative of the construct of anxiety. For the purpose of the present study, anxiety will be operationally defined as behavioral changes during the post-CS period in the CER paradigm.

Conditioned Emotional Response

Estes and Skinner (1941) demonstrated that a stable operant response could be interrupted by the presentation of a conditioned stimulus which has been repeatedly paired with a noxious unconditioned stimulus. The disruption of the ongoing operant by the presentation of a stimulus associated with a noxious event has been regarded as providing a behavioral index of anxiety. In addition to presenting a quantitative index of the performance decrement, Estes and Skinner reported the presence of behaviors, such as crouching and defecating, which were considered to be qualitative signs of anxiety.

The phenomenon of a neutral stimulus being repeatedly paired with shock and acquiring the property of disrupting ongoing behavior has been well replicated. Brady and Hunt (1950) have labeled this phenomenon "conditioned emotional response" (CER) while Stein, Sidman, and Brady (1958) have referred to it as "conditioned suppression." Both terms are prevalent in the literature.

Kamin and his colleagues (Annau and Kamin, 1961; Kamin, 1963, 1965; Kamin and Brimer, 1963; Kamin and Schaub, 1963) have performed a series of studies which examined the various parameters influencing CER. Using groups of rats as subjects, Annau and Kamin used UCS intensitites of .28, .49, .85, 1.55, and 2.91 ma. Excluding .28 ma., at which no suppression was obtained, they found a monotonic relationship between shock intensity and the amount of suppression. These results supported those of Notterman and Marton, (1958) which found a monotonic relationship using UCS intensities of 0, .5, 1.3, and 3.0 ma. Thus, with respect to the UCS, the literature indicated that the magnitude of the CER varied directly with the intensity of the UCS over the range reported.

Kamin and Schaub (1963), using a CS of 49, 63, or 81 db white noise, reported that the intensity of the CS bore a monotonic relationship to the intensity of the CER. When both CS and UCS intensity were varied, the influence of the UCS was paramount to that of the CS (Kamin and Brimer, 1963).

The dependent variable in CER studies is typically expressed in the form of a ratio which compares the number of responses emitted in the period between CS onset and UCS onset (B) with a comparable period immediately preceding CS onset (A). Among the formulas which have been proposed are:

(1) A/B	(Estes and Skinner, 1941)
(2) $(B-A)/A$	(Hunt, Jernberg, and Brady, 1952)
(3) $A/(A+B)$	(Annau and Kamin, 1961)
(4) $(A-B)/(A+B)$	(Dinc, 1965)

The difficulty with formulas (1), (2), and (3) is that a value of zero in the numerator or denominator produces ratios which are zero or indeterminate. When the denominator assumes a value of zero the ratio is indeterminate. When the value of the numerator is zero, the ratio is zero. In this latter case, no direct comparison of the magnitude of change between A and B is possible. The ratios obtained with the four formulas for the possible extremes and at $A=B$ are given below:

Formula	Ratio when A=0 (no pre-CS responding)	Ratio when A=B	Ratio when B=0 (no post-CS responding)
1	0.00	+1.00	indeterminate
2	indeterminate	0.00	-1.00
3	0.00	.50	+1.00
4	-1.00	0.00	+1.00

Formula (4) is the only formula proposed which has definite limits that indicate the magnitude of response suppression (+1.00) and/or facilitation (-1.00).

Whereas the CER has been reliably demonstrated with infrahuman species, this phenomenon has not been reliably obtained with humans. Kanfer (1958a,b) used a verbal response with human subjects in an investigation of the CER. The suppression paradigm used a 375 cps tone as the CS and a UCS of approximately .9 to 1.3 ma. dc. Subjects were instructed to "say separate words which came to mind, continuously until told to stop." Trials were of one minute duration, with CS onset occurring after the first 30 seconds. The duration of the CS-UCS delay was 30 seconds.

Kanfer reported that the Ss demonstrated an increase in verbal rate following CS onset. His data were plotted in group means and indicated an increase from the baserate of ten words/30 seconds to approximately 12.5 words/30 seconds. Although this difference was statistically significant at $p < .05$, it should be noted that the effect, in terms of suppression ratios, was quite small. If one assumes that the mean data were stable, then using formula (4) the computed ratio would be approximately -.10. In addition, it should be noted that Kanfer was using group means while most of the CER studies examined the effects of the CER paradigm on individual Ss. With infrahumans, the magnitude of the CER is such that ratios of ±.10 are considered as indicating stability, and the CER usually assumes a magnitude of -.80.

In considering his findings of a response facilitation rather than a response suppression, Kanfer hypothesized three possible variables which may have influenced the extent and direction of anxiety effects on continuous behavior. The proposed variables were:

(1) the type and intensity of the noxious UCS;
(2) the duration of the CS and the number of CS-UCS pairings;

(3) the complexity of the task and the degree of compatibility with the response to the noxious stimuli.

With respect to variables 1 and 2, some answers may be found in the literature with infrahumans. Annau and Kamin (1961), as reported previously, found that the magnitude of the CER was a monotonic function of the intensity of the UCS. It has also been reported that a greater intensity of shock was needed to suppress behavior when the shock was non-contingent upon the Ss' behavior, as in a CER paradigm, than when the shock was contingent upon behavior, as in punishment studies (Annau and Kamin, 1961).

Kamin (1963, 1965) has also reported that with a delayed conditioning paradigm the CER may be obtained with an interval as long as three minutes. Breznitz (1966) investigated the effect of the time interval between the threat of a frightening event (i.e, shock onset) and its occurrence on the intensity of fear as determined by an increase in human heart rate. He found that the longer the period of anticipation, the greater the increase in heart rate during the last minute of anticipation.

Studies which have used an UCS other than electric shock seem to favor the interpretation that electric shock produces greater suppression. Brody (1966) using monkeys as subjects, obtained moderate suppression using a one second noise of 115 db as his UCS. Riccio and Thach (1966) obtained no suppression with rats when they used vestibular stimulation as their aversive stimulus.

Leitenberg (1966) compared electric shock and time-out from reinforcement as aversive stimuli, each of these being paired with different conditioned stimuli. He found that pigeons showed suppression to the CS paired with shock but demonstrated response facilitation to the CS paired with a ten minute time-out. This difference between time-out and shock supports Kanfer's hypothesis that the type of UCS may influence both the extent and direction of anxiety effects on ongoing behavior.

Edelman (1965) utilized a CER paradigm with humans engaged in a stimulus matching task. Subjects were required to press a button mounted on the front of the apparatus. This response turned on one of 8 lights under which was a stimulus configuration. The Ss' task was to match the stimulus indicated by the light by pressing the button of the stimulus configuration which corresponded to the stimulus indicated by the light. Edelman used an auditory stimulus as his CS, with a 90 second delay period terminated by shock.

The intensity of the shock was determined by obtaining "pain" thresholds.

The overall effect of the CER paradigm was to increase the rate of behavioral responding, although there was much inter-subject variability. Two subjects exhibited response facilitation, two subjects showed no change, and one subject exhibited response suppression. The group pattern indicated an increase in mean number of responses/10 second interval for the first six intervals, and a decrease from the maximum rate as the CS approached, although the rate during this last 30 second period was still greater than that during baseline intervals. It should be noted that the range of responses/10 second interval was approximately 4.75 to 5.20. In addition to this small range, no statistics were reported, so that it is difficult to assess the consistency of the behavioral response from which to evaluate the change.

Sachs and May (1967) used a trace conditioning paradigm with a variable interstimulus interval in an attempt to maximize the Ss' anxiety by minimizing the cues associated with UCS onset. The operant response was a lever press. Although the data showed no change from baseline when the CER paradigm was introduced, the authors cited verbalizations emitted by their Ss which indicated that the Ss felt "anxious" when the CS occurred.

The studies cited above indicate that the only consistency with respect to the CER with humans is the lack of consistency. Whereas Kanfer reported response facilitation for verbal rate, Edelman has reported facilitation, suppression, and no change with an 8-stimulus matching task, and Sachs and May have reported no change using a bar press response. The differences obtained may be due to the different types of responses which were used, ranging from a simple bar press to an 8-stimulus matching task. The only evidence for response suppression occurred with the more complex of these responses, namely the 8-stimulus matching task. This gives some support to Kanfer's hypothesis that the complexity of the continuous task may be an important variable in determining the effect of the CER procedure.

Wherry and Curran (1966), independent of the CER literature, arrived at many of the same conclusions which have been determined via CER research. These authors emphasized that "the real issue in threat research is the manner in which the individual perceives his environment." They criticized studies in which imaginary or unrealistic stress was supposedly generated by threatening the Ss with some outcome which, in fact, never occurred or occurred at a very low probability. Wherry and Curran then proceeded to propose a model of psychological stress. The major factors in this model were:

(1) the perceived proximity of the event if it occurred;
(2) the perceived unpleasantness of the event if it occurred;
(3) the composite anticipatory physical threat stress (APTS) generated.

Among the variables which influenced these parameters were:

(a) the time since last occurrence of the event;
(b) the intensity of the event;
(c) the duration of the event;
(d) the "area of self to be hurt" if the event occurred;
(e) the perceived duration of pain if the event occurred;
(f) the perceived time until the event occurred.

Wherry and Curran derived the following formula which may easily be applied to CER research:

$$\text{APTS} = \frac{f\ (P'_U\ .\ f(I'),}{f\ (T'_E)}$$

where P'_U is the time since the last occurrence of the event, I' is the intensity of the event, and T'_E is the time until the event occurs. With respect to CER literature, P'_U has been investigated by Stein, Sidman, and Brady (1958), who found that a short CS duration tended to produce the greatest suppression. I' relates to the CS and UCS intensity studies of Annau and Kamin (1961), Notterman and Marton (1958), and Kamin (1963). Edelman's study (1965), which investigated the change in behavior as the occurrence of the UCS approached, and a study by Davis, McIntire, Ochis, and Cohen (1967) which found that the use of a variable interstimulus interval tended to maximize suppression, would relate to the variable T'_E.

Wherry and Curran (1966) had their Ss perform a color matching task using four colors and four response levers. A row of lights was mounted behind the levers and facing the S. The center light was red and labeled "time zero." Lights to the left of "time zero" were yellow and those to the right were green. Starting at the left, each light stayed on for 10 seconds, and on its termination the next light went on. Shock was delivered with probabilities of occurrence of either .2 or .8, and the Ss were aware of which probability they were operating under. Shock occurred at the offset of the red light. In addition to the probability of the shock, Ss knew whether the intensity of the impending shock was to be "mild" or "painful."

Thus, this design may be viewed from the paradigm of a CER design, with a 190 second interstimulus interval if each of the lights is considered as representing the CS, or with a 10 second interstimulus interval if only the red light is considered as the CS. The authors, in analyzing their data, considered the nine lights preceding "time zero" as their CS. They reported that as "time zero" approached, Ss showed a 5% decrease in the number of correct responses as compared with the baseline condition (the first 100 seconds). The authors also found that of the Ss who received "mild" shock, only those who received this shock at a probability of .8 demonstrated performance decrement. Both .8 and .2 probability groups receiving a "pain" level shock demonstrated performance decrement. A statistical analysis indicated a significant triple interaction between proximity of the UCS, probability of the UCS, and unpleasantness of the UCS at $p < .001$. Although these authors neither referred to their procedure in terms of classical conditioning procedures, nor cited any CER literature, this study remains quite relevant to the latter body of knowledge.

Task Complexity and Anxiety

In considering studies which have examined the effects of anxiety on the performance of complex tasks, it is necessary to return to the concept of anxiety as being a measurable entity independent of behavior. Spielberger (1966) has taken the position that it is possible to distinguish between anxiety as representative of a transitory condition of the organism and anxiety as a personality trait. Trait anxiety (A-trait) has been conceptualized as the anxiety proneness of an individual and state anxiety (A-state) has been conceptualized as a transitory condition of the organism which varies in intensity and fluctuates over time. Spielberger, Gorsuch, and Lushene (1968) have considered the Taylor Manifest Anxiety Scale (TMAS), and the Welsh Factor A Scale of the MMPI to be measures of trait anxiety.

Spielberger has developed the State-Trait Anxiety Inventory (also called the Self Analysis Questionnaire) as a means of assessing an individual's level of A-trait and A-state. Speilberger, et al. (1968) have reported that the reliability of the A-state measure varied depending upon the conditions under which this test was given. These authors reported that A-trait measures correlated .67 - .77 with the TMAS and .78 with the Welsh Factor A Scale. They also reported that the test-retest reliability of the A-trait scale is of the order of .80 (Spielberger, et al., 1968).

Most of the studies which have used test scores to define anxiety as the independent variable have utilized the Taylor Manifest Anxiety Scale (Taylor, 1951, 1953.) These studies typically selected groups on the basis of a range of scores which were considered as representative of either high anxiety (HA) or low anxiety (LA). The effects of some procedure, such as induced threat, on the performance and/or acquisition of some behavioral response were investigated.

Taylor and Spence (1952) reported that in learning a complex verbal maze HA Ss performed poorly compared to LA Ss. This pattern of HA Ss performing more poorly than LA Ss on a complex task contrasted with the results obtained with a simple task, eyelid conditioning (Taylor, 1951), in which the HA group was superior. Farber and Spence (1953) reported that HA Ss were superior to LA Ss in eyelid conditioning, but the LA group was superior in learning a complex stylus maze. Neither Taylor and Spence (1952) nor Farber and Spence (1952) parametrically manipulated the variable of task complexity.

Davidson, Andrews, and Ross (1956) manipulated stress by (1) reporting false failure scores to Ss and (2) by increasing the speed at which the stimuli were presented in a task of high speed color matching. The Ss were divided into HA and LA groups based on TMAS scores. Ss who were given false reports that they were performing "below" their expected level also received electric shock upon completion of a trial in which they were informed of their "failure". These Ss were "told that the apparatus was set to deliver automatically an electric shock at the end of each test period" on which their performance was "below" the expected level (Davidson, Andrews, and Ross, 1956, p. 14). It should be noted that this latter procedure constituted punishment since the noxious stimulus was contingent upon a given behavior (i.e.. failure). Both HA and LA subjects showed significant increases in errors as a result of increasing the speed of stimulus presentations, although threat of failure produced no effect with either group.

Sarason and Palola (1960) attempted to manipulate task complexity by using the Wechsler-Bellevue digit symbol subtest and a modification of the digit symbol test in which the symbols were all variations of the letter "L". HA and LA groups were selected on the basis of TMAS scores and compared on difficult and easy forms of the digit symbol test. In addition, one-half of the Ss were given "stressful" instructions which related their performance to their "intellectual level" while one-half of the Ss received "verbal instructions." The design of the experiment was factorial. Sarason and Palola found that on the easy task, the HA Ss performed better than LA Ss for both IQ and neutral conditions.

Shepard and Abbey (1958) investigated HA and LA Ss, selected using the TMAS, on a complex perceptual motor task in which the Ss were required to match stimuli. Their findings, that the performance of the LA Ss was superior, were consistent with the results of Taylor and Spence (1952) and Farber and Spence (1952).

Murphy (1959) has proposed a set of variables which he believes influence the complexity of a task. Among the variables cited are

(1) the amount of search required to perceive relevant cues;
(2) the degree to which cues are confused;
(3) the number and complexity of the demands made upon the operator.

Whereas the tasks in the experiments cited were "more complex" by virtue of their satisfying the variable of making the stimuli to be discriminated "more similar," none of the studies cited had quantitatively attempted to manipulate task complexity.

The latter criticism has been satisfied in a study by Hokanson and Burgess (1964). These authors used a modified digit symbol task and controlled the number of digit symbol pairs presented to the S. The authors used 4, 8, 16, and 32 pairs of stimuli and quantified the task difficulty dimension by using the information theory concept of uncertainty.

Brown (1966) compared HA and LA Ss selected on the basis of TMAS scores in a functional design using three different lists of nonsense syllables which varied in similarity and association value. Although differences between HA and LA groups with respect to the complexity of the list were not significant, Brown reported that there was a trend for LA Ss to perform slightly better than HA Ss. This was interpreted as being consistent with the findings of Taylor and Spence (1952). Brown divided his Ss into two groups, one of which received a threat of shock if they were to exceed a certain number of wrong responses. The results of this latter procedure indicated that the threat of shock resulted in an improvement of performance with the less difficult lists for the HA groups.

Among the notable deficiencies in the research which has been reviewed here are (1) the general failure to attempt to quantify task complexity, and (2) the general lack of functional designs in the investigation of the effect of anxiety on task complexity. A third factor is that studies which have attempted to relate anxiety to task complexity have focused on the acquisition of the task, rather than examining the effects of anxiety on the asymptotic level of performance. The latter difficulty is typically not present in CER studies since the level of performance in CER studies are at a stable level prior to the introduction of the CER paradigm.

Statement of Problem

The present study was designed to investigate the effect of task complexity on the CER. Murphy (1959) has proposed that (1) the amount of search required to perceive relevant cues and (2) the number and complexity of the demands made upon the operator are variables which influence the complexity of a task. Based on Murphy's proposal, task complexity was defined as increased when the number of available stimuli and/or responses increased.

The rationale behind considering task complexity as an important variable with respect to influencing the CER with humans, as reported previously, was based on Kanfer's third hypothesis (1958a), and on a consideration of the studies of Edelman (1965) and Sachs and May (1967).

Hypotheses

1. Response suppression will increase as task complexity increases. Research on infrahumans has demonstrated that the effect of the CER procedure produced response suppression during the post-CS period. In addition, research with humans has demonstrated that when CER procedures were used with a simple task, no change in response rate occurred during the post-CS period, although Ss emitted responses, such as bracing their inoperative arm, when the CS occurred.

Increasing the task complexity by requiring the S to work with more stimuli and responses, as well as using stimulus configurations which are similar, should result in the S having to pay more attention to the task than would be necessary with a simple response such as a lever press. If this is so, any response produced by the CS-UCS pairings should result in an interference with the performance of the stimulus matching task.

If hypothesis 1 is true, then
Response Rate (RR) = $f(x_1, x_2) + e$
Response Latency (RL) = $f(x_1, x_2) + e$
Stimulus Presentation Time (SPT) = $f(x_1, x_2) + e$

where x_1 represents the factor of task complexity and x_2 represents the factor of baseline condition.

2. Sex differences will be found between S with respect to the interaction between CER and task complexity. Although CER research, up to the present time, has not considered sex as a factor, human research in other areas using noxious stimuli (Hokanson and Edelman, 1966) has tended to find male-female differences in their reaction to noxious stimuli.

If hypothesis 2 is true, then
$RR = f(x_1, x_2, x_3) + e$
$RL = f(x_1, x_2, x_3) + e$
$SPT = f(x_1, x_2, x_3) + e$

where x_3 is the factor of sex, and x_1 and x_2 are defined above.

3. The CER procedure will result in greater variability in the presence of the CS than in the absence of the CS. In an earlier study (Sachs and May, 1967) casual observation of the data indicated an increase in the variability of the response rate during the post-CS interval, although no change in response rate was reported. The third hypothesis is derived from that observation.

If hypothesis 3 is correct, then
$V_{RR} = f(x_1, x_2) + e$
$V_{RL} = f(x_1, x_2) + e$
$V_{SPT} = f(x_1, x_2) + e$

The symbol V denotes variance.

METHOD

Subjects

The Ss for this study were three male and three female students from The Florida State University. Subjects were selected from those students who responded to a posted request for long-term Ss and who had indicated that they would be available for a period of four consecutive months. None of the Ss was majoring or minoring in psychology and none reported any history of cardiac disorders, high blood pressure, or epilepsy.

Apparatus

Stimuli.--The stimuli consisted of 8 configurations constructed so that 90^{o} rotations would change the directional orientation of the configurations (i.e., up, down, left, and right). The 8 configurations used are illustrated in Fig. 1. Each of the 8 configurations was rotated 0^{o}, 90^{o}, 180^{o}, and 270^{o} producing a total of 32 perceptually distinct stimuli. These stimuli were presented using 35 mm slides.

Experimental Room.--The Ss were seated in a room facing a screen, the dimensions of which were 21" x 26.5". The screen itself was .010 rigid vinyl, produced by Transilwrap. Slides were projected by a Davis Scientific PP-153 Slide Projector. Two toggle switches, 42" apart, were mounted on the bottom of the table on which the screen and projector rested. In order to change slides it was necessary to have both switches simultaneously depressed.

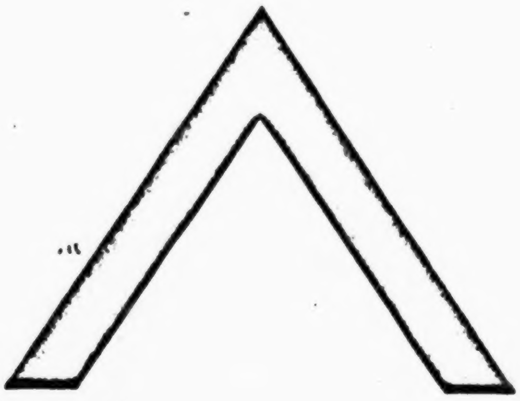
The response apparatus consisted of two double-banked panels, with 8 toggle switches per bank. The dimensions of each bank were 7" x 23" with the 8 switches on each bank located 2 3/4" apart. One of the double-banked panels was to the right of the screen and the other double-banked panel was to the left of the screen. A response consisted of the S depressing a toggle switch.

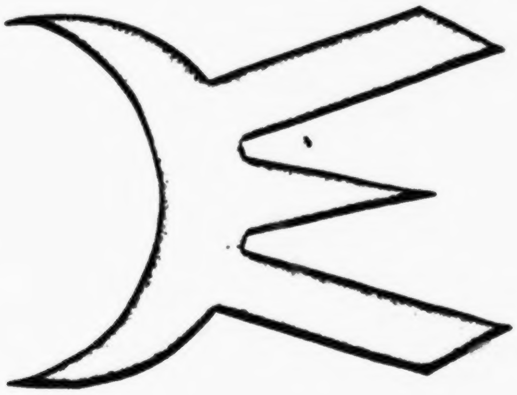
For the 8-stimulus task only the 8 stimulus configurations in the 0^{o} position were mounted on the response banks, with two of these stimuli being randomly assigned to each bank. For the 16-stimulus task there were 4 stimuli per response bank. This was accomplished by randomly selecting one of the remaining possible rotations (90^{o}, 180^{o}, or 270^{o}) of each of the original 8 stimulus configurations and then randomly assigning 2 of these additional stimulus configurations to each response bank. The remaining 16 stimulus configurations were randomly placed above the available switch positions for the 32-stimulus task.

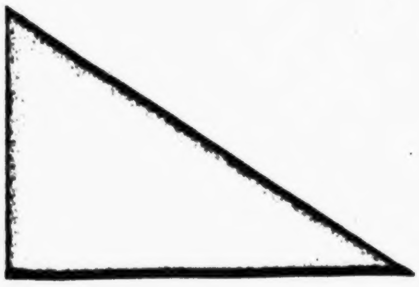
Conditioned stimulus and unconditioned stimulus.--The CS was a 2100 cps tone, produced by a General Radio Oscillator, and amplified to a power of -25db by a Heathkit Amplifier. (The reference intensity was Odb = 1 milliwatt at 600 ohms with the power measured using a multimeter.) The CS was delivered via a 12" speaker, located 4 1/2 feet from the S, directly in front of the S but hidden from view by the projection screen.

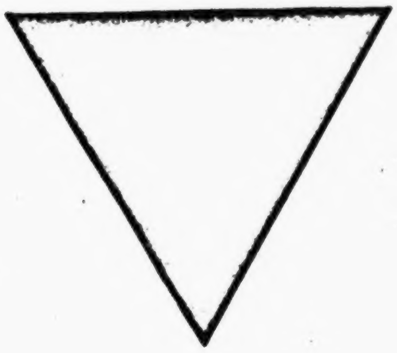
The UCS was a .75 second dc shock, produced by a Variac and a rectifier, delivered to the S by means of

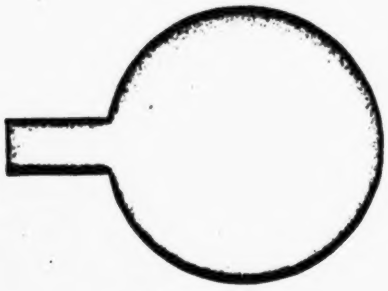
Fig. 1.--The 8 basic stimulus configurations used as stimuli to be matched. Each of these 8 configurations was rotated 0°, 90°, 180°, and 270° to produce a total of 32 perceptually distinct stimuli.

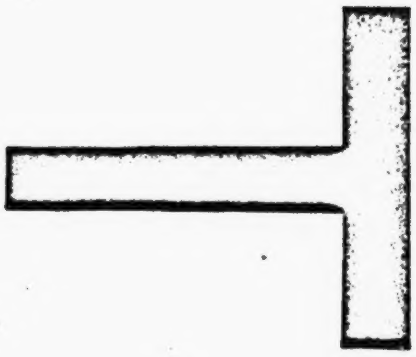


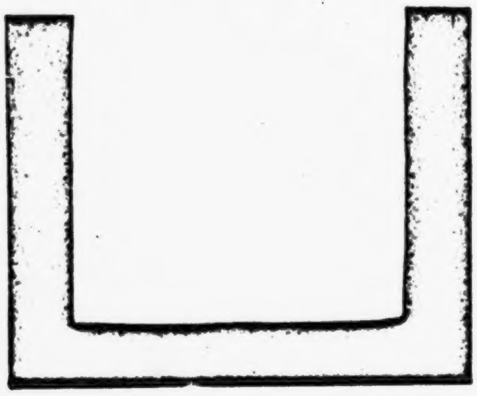












finger tip electrodes. Both leads of the shock circuit were fused between the rectifier and the S with a 1/200 amp. fuse as a safeguard against any unexpected power surge. A schematic of the shock circuit is presented in Fig. 2.

Programming and recording.--All programming and recording were accomplished by means of electromechanical devices located in a room directly across from the room in which the S was working. The soundproofed ceiling, heavy wooden of each room, and masking noise of the slide projector prevented the S from hearing the operation of the electromechanical equipment.

Procedure

Prior to beginning the experiment each S was given the following form to sign:

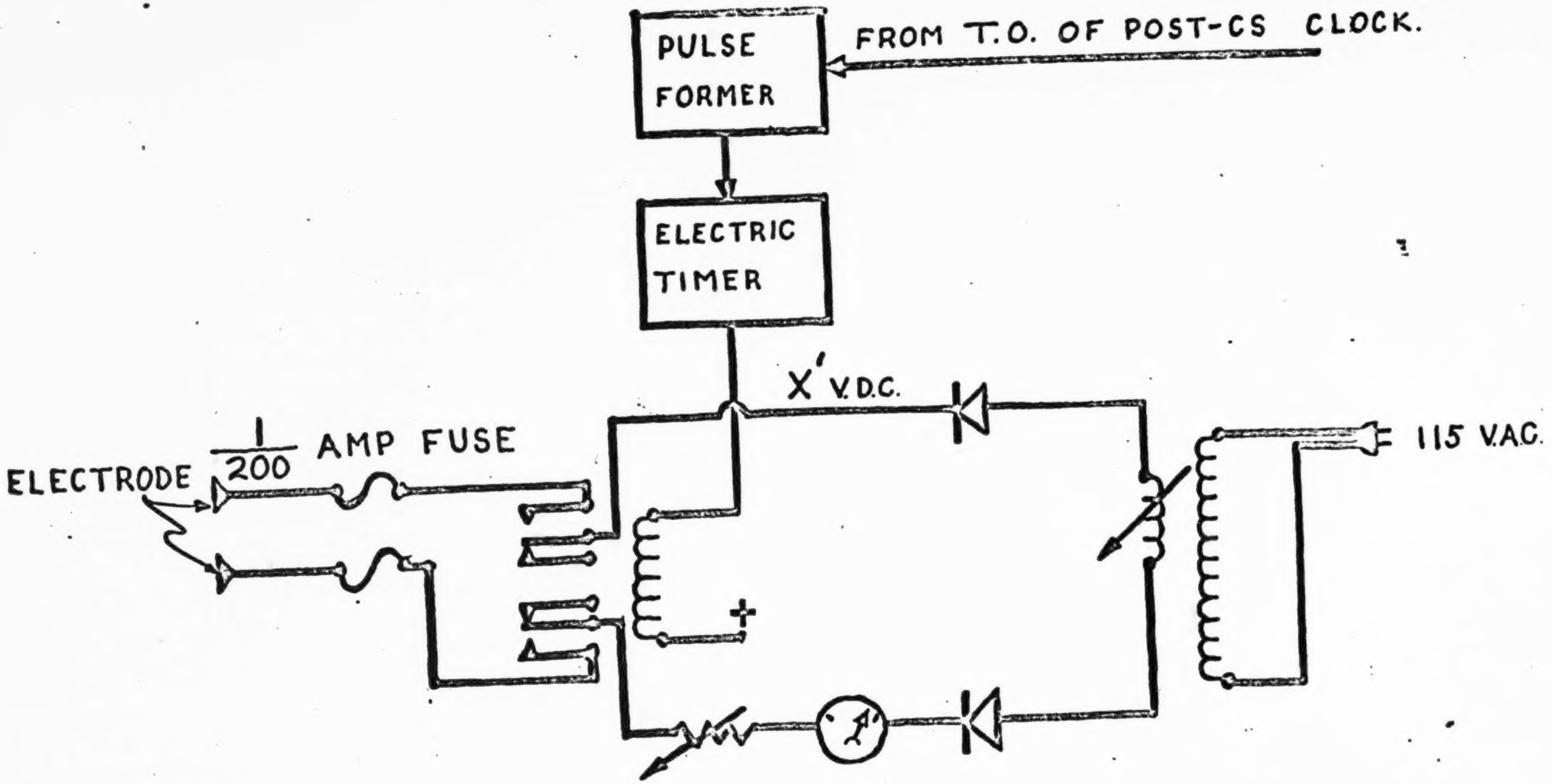
> We are engaging in research designed to study various emotional behaviors over an extended period of time. In order to do this, it will be necessary for us to employ shock at various periods of time. If you agree to serve as a subject, you do so with the knowledge that at some points during the experiment shock will be used.
>
> Your consent to serve as a subject knowing of the use of shock in no way restricts your freedom to terminate the experiment at any time you so choose.

Electrodes were placed on the 2nd and 3rd fingers of each hand and held in place with rubber finger tips. The Ss were told that the electrodes were used for the recording of physiological data as well as to administer shock. They were then shown how to present the stimuli to themselves and how to make a response. Responses were reinforced on a VI2' schedule. To indicate the occurrence of reinforcement a point counter was mounted alongside the screen to the S's right. At the conclusion of each session each S received 5¢ for each point he had obtained on the counter. In addition to this daily reinforcement, each S received a $1.00 bonus on Friday if he had missed no sessions during that week, and a bonus of $5.00 for every 20 consecutive sessions without an absence.

Sessions lasted approximately 60 minutes, during which time each S was instructed to match the stimulus that appeared on the screen by pressing the response key that had the picture of the correct stimulus beneath it.

Three dependent measures were recorded as each S

Fig. 2.--Schematic representation of the shock circuit used to deliver the UCS.


PULSE FORMER
FROM T.O. OF POST-CS CLOCK.
ELECTRIC TIMER
X' V.D.C.
$\frac{1}{200}$ AMP FUSE
ELECTRODE
+
115 V.A.C.

SCHEMATIC

performed. Response latency (RL) was the amount of time between the presentation of a stimulus and the occurrence of the matching response. Stimulus presentation time (SPT) was the amount of time between the occurrence of the matching response and the presentation of the next stimulus. RL and SPT were recorded to the nearest 1/2 second. Response rate (RR) was the total number of stimulus presentations and responses that were emitted in a 45" period.

8-Stimulus task.--Each S began with the 8-stimulus task. Baselines of performance were obtained by taking ten probes per session, each probe consisting of two consecutive 45" periods. Neither the CS nor the UCS was presented on the probes but the first period was treated as the pre-CS period (A) and the second period was treated as the post-CS period (B). In order to establish baseline suppression ratios, ratios of SPT, RL, and RR were computed using the formula (A-B)/ (A+B).

There being no accepted criteria of stability using human Ss in a stimulus matching task, the criteria of stability in this study were determined on the basis of pilot data. The criteria selected were stringent since all 3 dependent measures had to simultaneously meet the same requirements. The S's level of performance was considered stable when for a period of 4 consecutive days none of the mean daily ratios for either of the three dependent measures was $> \pm .05$, and in addition, the ratios from no more than 5% of the individual probes for each of the dependent measures during this four-day period were as large as $\pm .20$.

After his performance had stabilized, each S was presented with 5 trials of CS alone to test for pseudoconditioning. Pseudoconditioning was considered to be present if the mean ratio for any of the 3 dependent variables during pseudoconditioning trials was $> \pm .05$. If pseudoconditioning occurred, continued CS presentations were delivered with 5 presentations per session until the pseudoconditioned response was extinguished. Extinction of the pseudoconditioned response was defined as having occurred when the mean ratio for each of the 3 dependent measures was equal to or less than $\pm .05$.

Shock Thresholds

The intensity of the shock to be delivered was individually determined for each S using an ascending method of limits. Each S reported when he first detected the shock, when the shock felt "uncomfortable" and when the shock felt "painful." Separate thresholds were obtained for right and left hands. A Variac setting 5 units (approximately

5 volts) above the level at which each S reported feeling a "painful" shock was used as the intensity of the UCS. The range of intensities for the 6 Ss was 1.8 - 3.2 ma (55 - 95 volts).

Thresholds were initially determined during the first day on which each S began to participate in the experiment. Thresholds were randomly rechecked throughout the course of the experiment. When thresholds were rechecked, this was always done at the beginning of a session and with the slide projector off.

Conditioned Emotional Response Training

A conditioned emotional response (hereafter referred to as CER) trial consisted of the presentation of the CS for a 45" duration, with CS offset being paired with the onset of the "painful" level of electric shock. Shock was randomly alternated between the two hands. Five CER trials per day were randomly dispersed in the session for a period of seven days. During CER trials, CS offset was simultaneous with the delivery of shock. The magnitude of the CER was determined using the formula (A-B)/(A+B) for all three dependent measures. This allowed for a comparison of the effect of the CS-UCS pairings on performance with a comparable 45" period in which the CS was not present. In addition, 5 probes were randomly scheduled during each session of CER training. The procedure for obtaining probes was identical to that used in obtaining baselines.

Following completion of CER procedures for the 8-stimulus task, each S was trained on the 16-stimulus task. Baseline and CER procedures for the 16, and finally the 32-stimulus task were identical to those of the 8-stimulus task, with the exception that for these latter two tasks, no test for pseudoconditioning was possible.

After completing all 3 complexity levels of the behavioral task, each S was administered forms B and B-1 of the Self Analysis Questionnaire (Spielberger, Gorsuch, and Lushene, 1968) to estimate his level of A-trait and A-state. The instructions for the A-state scale (form B-1) were slightly modified to investigate the S's reported feelings at the time CS onset occurred. In addition to the Self Analysis Questionnaire, each S was given a 7-question form designed to determine his awareness of the experimental contingencies and how he attempted to cope with the experimental situation. The Self Analysis Questionnaire and the 7-question form are presented in Appendices A and B respectively.

RESULTS

The results will be presented in four sections. The section on group data will consist of a description of the statistical procedures used, and will be followed by the analyses of variance which were used to test hypotheses 1 and 2 for each of the dependent variables. Hypothesis 3 will be presented following the presentation of the analyses of variance since the test for this hypothesis was based on the standard deviations of each *S* for each level of task complexity.

The second section will present the mean data for each *S*. Individual *S* data converted into suppression ratios will be presented in the third section. The last section will examine the relationship between the *Ss*' performance on the behavioral task and their scores on the Self Analysis Questionnaire.

Group Data

The dependent variables of response rate (RR), response latency (RL), and stimulus presentation time (SPT) were each used in 2 five-factor analyses of variance . For response rate (RR), the unit of analysis was the number of stimulus presentations plus the number of matching responses that occurred in the 45" interval sampled. The unit of analysis for response latency (RL) was the mean number of 1/2 seconds that elapsed between a stimulus presentation and a matching response. This was calculated by dividing the total number of 1/2 seconds of response latency during the 45" interval sampled by the number of matching responses which were made during that 45" interval. For stimulus presentation time (SPT), the unit of analysis was the mean number of 1/2 seconds that elapsed between a matching response and the presentation of a new stimulus. This was calculated by dividing the total number of 1/2 seconds of stimulus presentation time during the 45" interval by the number of stimuli which were presented during the 45" interval.

The statistical design involved the analysis of the following five sources of variance, of which all but sex were repeated measures.

(1) Complexity: The number of stimuli involved in the task, either 8, 16, or 32;

(2) Condition: The experimental procedure operative at the time of sampling, either Baseline, Shock-baseline, or Shock. Each analysis of variance compared two conditions;

(3) Sex: Male or female Ss;

(4) Trials: Thirty-five trials were used in each condition. For Baseline, the last 35 trials prior to beginning CER training were used. Shock-baseline consisted of the 35 probes taken during the 7-day training period. Shock trials consisted of the 35 CS-UCS pairings during the 7-day training period;

(5) Pre-post: Refers to the comparison of the magnitude of the dependent variable between two successive 45" time periods.

One analysis of variance compared the conditions of Baseline performance (obtained using the last 35 probes prior to the initiation of CER training procedures) and Shock-baseline performance (obtained by the 35 probes taken during CER training but not during CS or UCS presentations). The second analysis of variance compared Shock-baseline performance (as defined above) and Shock performance (obtained by using the 35 trials during which UCS-CS pairings occurred). Baseline - Shock-baseline and Shock-baseline - Shock analyses of variance were computed separately for each of the dependent measures.

Although the dependent measures were stable prior to the commencement of CER training, the possibility existed that CER training could affect the overall stability of performance. Baseline - Shock-baseline analyses of variance were undertaken to determine whether the stability of the dependent measures was affected by CER training.

Response Rate

The analysis of variance of RR for the Baseline - Shock-baseline comparison is presented in Table 1. The main effect of complexity and interactions of complexity x condition, complexity x sex, condition x sex, sex x trials, and complexity x condition x sex were significant at $p < .01$ and the main effect of pre-post was significant at $p < .05$. The significant main effect of complexity indicated that RR was affected by the complexity of the task.

Table 2 presents the analysis of variance of RR for the Shock-baseline - Shock comparison. This analysis was of major importance since it compared RR during CS-UCS pairings with RR when no CS-UCS pairings were present. The main effects of complexity and pre-post, and interactions of complexity x condition, complexity x sex, condition x sex, condition x pre-post, sex x pre-post, complexity x condition x sex, and condition x sex x pre-post were all significant at

TABLE 1

ANALYSIS OF VARIANCE OF RESPONSE RATE FOR
BASELINE - SHOCK-BASELINE COMPARISON

	Source	df	MS	F
Between	S	1	7626.76825	1.435
	error	4	5313.46930	
Within	C	2	794.69802	81.420**
	Cn	1	16.15254	1.655
	T	34	6.40518	<1.0
	P	1	59.73968	6.121*
	CCn	2	111.71944	11.446**
	CS	2	890.85040	91.271**
	CT	68	5.73396	<1.0
	CP	2	.66944	<1.0
	CnS	1	1229.20635	125.938**
	CnT	34	6.51069	<1.0
	CnP	1	.10159	<1.0
	ST	34	16.98721	1.740**
	SP	1	.01429	<1.0
	TP	34	2.09009	<1.0
	CCnS	2	182.71944	18.720**
	CCnT	68	5.36895	<1.0
	CCnP	2	.63373	<1.0
	CST	68	7.05710	<1.0
	CSP	2	1.75833	<1.0
	CTP	68	2.72908	<1.0
	CnST	34	7.30439	<1.0
	CnSP	1	.07778	<1.0
	CnTP	34	4.26335	<1.0
	STP	34	2.67115	<1.0
	CCnST	68	6.28317	<1.0
	CCnSP	2	3.71944	<1.0
	CCnTP	68	2.83961	<1.0
	CSTP	68	3.45441	<1.0
	CnSTP	34	2.79020	<1.0
	CCnSTP	68	3.11569	<1.0
	error	1676	9.76045	

** = $p < .01$
 * = $p < .05$
C = Complexity, Cn - Condition,
S = Sex, T = Trials, P = Pre-post

the $p < .01$ level.

The major difference between the Baseline - Shock-baseline comparison and the Shock-baseline - Shock comparison was the presence of significant interactions in the Shock-baseline - Shock comparison involving the pre-post factor. Although the pre-post main effect was significant at $p < .05$ for the Baseline - Shock-baseline comparison, there were no significant pre-post interactions present. The observation that there were no significant pre-post interactions for the Baseline - Shock-baseline comparison does not influence the interpretation of the pre-post interactions for the Shock - Baseline shock comparison.

The significant pre-post interactions presented in Table 2 indicate that RR changed following the onset of the CS. Hypothesis 1, that response suppression was a function of task complexity, could not be accepted for RR since the complexity x condition x pre-post interaction was not significant. Although this hypothesis could not be accepted, examination of individual S data implied that if a S showed performance decrement, the magnitude of the decrement was related to the complexity of the task.

Since hypothesis 2, that sex differences were expected to be found between Ss with respect to the interaction between CER and task complexity, required that hypothesis 1 be accepted, hypothesis 2 could not be accepted. The significant complexity x condition x sex interaction ($p < .01$) implied that males and females were differentially affected by task complexity. The significant condition x sex x pre-post interaction ($p < .01$) implied that males and females reacted differently to the CER procedure. However, the complexity x condition x sex x pre-post interaction necessary to accept hypothesis 2, as initially presented, was not significant.

Response Latency

Table 3 presents the analysis of variance of the Baseline - Shock-baseline comparison for RL. The main effect of complexity and interactions of complexity x condition, complexity x sex, condition x sex, sex x trials, and complexity x condition x sex were all significant at $p < .01$. Since RR and RL were interrelated, it was not surprising that the significant main effect and interactions indicated by the Baseline - Shock-baseline analysis of variance for RR, with the exception of the pre-post main effect, were also found in the Baseline - Shock-baseline analysis of variance for RL. As RR decreased RL must have increased, since fewer responses were made during the fixed period of time.

TABLE 2

ANALYSIS OF VARIANCE OF RESPONSE RATE FOR SHOCK-BASELINE - SHOCK COMPARISON

	Source	df	MS	F
Between	S	1	7658.11468	2.509
	error	4	3062.86690	
Within	C	2	714.32421	38.921**
	Cn	1	27.44802	1.496
	T	34	11.53495	<1.0
	P	1	197.23214	10.747**
	CCn	2	143.93373	7.275**
	CS	2	228.98135	12.476**
	CT	68	6.69349	<1.0
	CP	2	23.90833	1.275
	CnS	1	2399.47659	130.739**
	CnT	34	5.25275	<1.0
	CnP	1	291.44802	15.880**
	ST	34	16.10570	<1.0
	SP	1	336.60357	18.340**
	TP	34	4.10551	<1.0
	CCnS	2	1119.62421	61.004**
	CCnT	68	3.93700	<1.0
	CCnP	2	2.02421	<1.0
	CST	68	6.31060	<1.0
	CSP	2	13.50833	<1.0
	CTP	68	3.43121	<1.0
	CnST	34	3.89407	<1.0
	CnSP	1	488.04802	26.592**
	CnTP	34	3.08772	<1.0
	STP	34	5.38380	<1.0
	CCnST	68	5.01718	<1.0
	CCnSP	2	40.68611	2.217
	CCnTP	68	3.98721	<1.0
	CSTP	68	3.98721	<1.0
	CnSTP	34	4.07824	<1.0
	CCnSTP	68	3.04477	<1.0
	error	1676	18.35318	

** = $p < .01$
C = Complexity, Cn = Condition,
S = Sex, T = Trials, P = Pre-post

TABLE 3

ANALYSIS OF VARIANCE OF RESPONSE LATENCY FOR BASELINE - SHOCK-BASELINE COMPARISON

	Source	df	MS	F
Between	S	1	135.46485	1.241
	error	4	109.14507	
Within	C	2	254.87780	725.941**
	Cn	1	.28438	<1.0
	T	34	.31752	<1.0
	P	1	.00077	<1.0
	CCn	2	59.30544	168.913**
	CS	2	16.95421	48.289**
	CT	68	.36292	1.034
	CP	2	.19674	<1.0
	CnS	1	35.12389	100.040**
	CnT	34	.21477	<1.0
	CnP	1	.00004	<1.0
	ST	34	.72140	2.055**
	SP	1	.00341	<1.0
	TP	34	.10977	<1.0
	CCnS	2	2.70850	7.714**
	CCnT	68	.30641	<1.0
	CCnP	2	.26008	<1.0
	CST	68	.30119	<1.0
	CSP	2	.09061	<1.0
	CTP	68	.15520	<1.0
	CnST	34	.37466	1.067
	CnSP	1	.35738	1.018
	CnTP	34	.19210	<1.0
	STP	34	.13775	<1.0
	CCnST	68	.21484	<1.0
	CCnSP	2	.31787	<1.0
	CCnTP	68	.16629	<1.0
	CSTP	68	.19801	<1.0
	CnSTP	34	.20558	<1.0
	CCnSTP	68	.14750	<1.0
	error	1676	.35110	

** = $p < .01$
C = Complexity, Cn = Condition,
S = Sex, T = Trials, P = Pre-post

Table 4 presents the analysis of variance of the shock-baseline - Shock comparison for RL. The main effects of complexity, condition, and pre-post and the interactions of complexity x condition, complexity x sex, condition x sex, sex x pre-post, complexity x condition x sex, and condition x sex x pre-post were all significant at $p < .01$. The conclusions warranted by these results for RL were identical to those presented for RR. Both hypotheses 1 and 2, as originally presented, were not accepted for RL.

Stimulus Presentation Time

Tables 5 and 6 present the Baseline - Shock-baseline and Shock-baseline - Shock comparisons, respectively, for the dependent variable of SPT. For the Baseline - Shock-baseline comparison, the main effects of complexity and condition, and the interactions of complexity x condition, complexity x sex, condition x sex, condition x trials, and complexity x condition x sex were significant at $p \quad .01$ and the interaction of complexity x condition x sex x trials was significant at $p < .05$. For the Shock-baseline - Shock comparison the interactions of complexity x sex and complexity x condition x sex were significant a $p < .01$. Since there was no change in the pre-post main effect for SPT, neither hypothesis 1 nor hypothesis 2 was tenable for this dependent variable.

Table 7 presents the significant main effects and interactions for each of the three dependent variables for the Baseline - Shock-baseline and Shock-baseline - Shock comparisons. Reference to this table allows for consolidation of the data presented in Tables 1 - 6.

Hypothesis 3

The standard deviations of RR for pre- and post-CS periods during Baseline, Shock-baseline, and Shock conditions for each _S_ for each level of task complexity are presented in Table 8. None of the F ratios calculated from these data was significant. Although the post-CS standard deviations for _S_s 2, 3, and 4 appeared smaller than the standard deviations obtained during the control periods, these were not significant. Similar non-significant F ratios were obtained for RL and SPT. Based on the finding of non-significant F ratios for RR, RL, and SPT, hypothesis 3, that the CER procedure would produce greater variability in the presence of the CS than in the absence of the CS, was not accepted.

TABLE 4

ANALYSIS OF VARIANCE OF RESPONSE LATENCY FOR SHOCK-BASELINE - SHOCK COMPARISON

	Source	df	MS	F
Between	S	1	142.67625	2.1303
	error	4	66.97617	
Within	C	2	84.33774	149.801**
	Cn	1	3.61006	6.412**
	T	34	.33503	<1.0
	P	1	6.06621	10.775**
	CCn	2	12.43800	22.092**
	CS	2	6.93860	12.324**
	CT	68	.47507	<1.0
	CP	2	.20512	<1.0
	CnS	1	85.30240	151.514**
	CnT	34	.15200	<1.0
	CnP	1	1.54613	2.746
	ST	34	.47324	<1.0
	SP	1	5.11921	9.093**
	TP	34	.16808	<1.0
	CCnS	2	54.93170	975.696**
	CCnT	68	.18928	<1.0
	CCnP	2	.10255	<1.0
	CST	68	.23458	<1.0
	CSP	2	.26663	<1.0
	CTP	68	.19871	<1.0
	CnST	34	.22117	<1.0
	CnSP	1	7.99708	142.044**
	CnTP	34	.14079	<1.0
	STP	34	.15532	<1.0
	CCnST	68	.23708	<1.0
	CCnSP	2	.55583	<1.0
	CCnTP	68	.17462	<1.0
	CSTP	68	.15432	<1.0
	CnSTP	34	.15912	<1.0
	CCnSTP	68	.18019	<1.0
	error	1676	.56300	

** = $p < .01$

C = Complexity, Cn = Condition,
S = Sex, T = Trials, P = Pre-post

TABLE 5

ANALYSIS OF VARIANCE OF STIMULUS PRESENTATION TIME FOR BASELINE - SHOCK-BASELINE COMPARISON

	Source	df	MS	F
Between	S	1	121.95480	2.032
	error	4	60.01941	
Within	C	2	24.45029	185.630**
	Cn	1	2.88666	21.943**
	T	34	.18087	1.375
	P	1	.04040	<1.0
	CCn	2	15.95456	121.281**
	CS	2	.77816	5.915**
	CT	68	.13388	1.018
	CP	2	.00831	<1.0
	CnS	1	13.79804	104.888**
	CnT	34	.36415	2.768**
	CnP	1	.00164	<1.0
	ST	34	.15989	1.215
	SP	1	.00012	<1.0
	TP	34	.07098	<1.0
	CCnS	2	1.79998	13.641**
	CCnT	68	.12468	<1.0
	CCnP	2	.09738	<1.0
	CST	68	.15795	1.197
	CSP	2	.02415	<1.0
	CTP	68	.08142	<1.0
	CnST	34	.18307	1.392
	CnSP	1	.03094	<1.0
	CnTP	34	.08101	<1.0
	STP	34	.09554	<1.0
	CCnST	68	.17743	1.348*
	CCnSP	2	.08539	<1.0
	CCnTP	68	.08314	<1.0
	CSTP	68	.06873	<1.0
	CnSTP	34	.08650	<1.0
	CCnSTP	68	.05450	<1.0
	error	1676	.13155	

** = p < .01
 * = p < .05
C = Complexity, Cn = Condition,
S = Sex, T = Trials, P = Pre-post

TABLE 6

ANALYSIS OF VARIANCE OF STIMULUS PRESENTATION TIME FOR SHOCK-BASELINE - SHOCK COMPARISON

	Source	df	MS	F
Between	S	1	155.39210	2.003
	error	4	77.56101	
Within	C	2	2.84382	<1.0
	Cn	1	7.12221	2.481
	T	34	3.06626	1.068
	P	1	5.59963	1.951
	CCn	2	3.30613	1.152
	CS	2	18.39480	6.408**
	CT	68	2.51667	<1.0
	CP	2	1.85847	<1.0
	CnS	1	7.17333	2.499
	CnT	34	2.54871	<1.0
	CnP	1	5.31118	1.850
	ST	34	2.51977	<1.0
	SP	1	.08704	<1.0
	TP	34	3.11534	1.085
	CCnS	2	15.30397	5.331**
	CCnT	68	2.77243	<1.0
	CCnP	2	2.52283	<1.0
	CST	68	2.50657	<1.0
	CSP	2	3.16662	1.103
	CTP	68	2.67705	<1.0
	CnST	34	2.62481	<1.0
	CnSP	1	.02322	<1.0
	CnTP	34	2.62015	<1.0
	STP	34	3.04657	1.061
	CCnST	68	2.77655	<1.0
	CCnSP	2	3.20397	1.116
	CCnTP	68	2.85528	<1.0
	CSTP	68	2.53099	<1.0
	CnSTP	34	2.63186	<1.0
	CCnSTP	68	2.64215	<1.0
	error	1676	2.87080	

** = $p < .01$
C = Complexity, Cn = Condition,
S = Sex, T = Trials, P = Pre-post

TABLE 7

SIGNIFICANT FACTORS AS DETERMINED BY ANALYSES OF VARIANCE FOR BASELINE - SHOCK-BASELINE AND SHOCK-BASELINE - SHOCK COMPARISONS**

	Baseline - Shock-Baseline	Shock-Baseline - Shock
Response Rate	C	C
	P*	P
	CCn	CCn
	CS	CS
	CnS	CnS
	--	CnP
	ST	--
	--	SP
	CCnS	CCnS
	--	CnSP
Response Latency	C	C
	--	Cn
	--	P
	CCn	CCn
	CS	CS
	CnS	CnS
	ST	--
	--	SP
	CCnS	CCnS
	--	CnSP
Stimulus Presentation Time	C	--
	Cn	--
	CCn	--
	CS	CS
	CnS	--
	CnT	--
	CCnS	CCnS
	CCnST*	--

**Unless otherwise indicated, the level of significance is $p < .01$.

* = $p < .05$
C = Complexity, Cn = Condition,
S = Sex, T = Trials, P = Pre-post

TABLE 8

STANDARD DEVIATIONS OF RESPONSE RATE FOR EACH SUBJECT FOR EACH LEVEL OF COMPLEXITY AND CONDITION

		Condition					
		Baseline		Shock-Baseline		Shock	
Subjects	Level of Task Complexity	Pre-CS	Post-CS	Pre-CS	Post-CS	Pre-CS	Post-CS
S2	1	172.531	175.740	179.968	184.481	182.454	181.049
	2	162.981	165.585	163.675	167.995	166.144	158.123
	3	143.370	145.879	148.453	152.084	149.761	133.909
S3	1	164.133	166.091	177.888	180.011	179.293	171.274
	2	175.300	175.743	178.320	179.654	178.800	167.122
	3	162.422	165.806	158.230	161.108	162.033	143.865
S4	1	175.988	174.737	192.270	191.325	192.439	173.397
	2	193.495	194.889	224.017	225.364	222.978	181.564
	3	209.382	212.280	237.535	233.559	232.999	178.694
S1	1	148.753	149.980	126.453	128.580	123.906	129.044
	2	126.427	128.083	126.662	128.159	125.154	134.565
	3	121.652	121.044	108.246	113.077	113.007	125.121
S5	1	208.883	215.620	185.109	189.880	184.654	179.352
	2	169.409	170.812	174.533	173.045	171.163	170.816
	3	163.861	165.927	165.907	167.854	168.018	167.578
S6	1	179.360	178.319	175.548	179.395	180.330	184.489
	2	167.812	166.976	170.121	170.115	169.609	173.573
	3	165.154	167.782	170.138	171.956	170.162	174.606

Individual Subject Data

Ss 2, 3, and 4 were males and Ss 1, 5, and 6 were females. Since sex was indicated to be related to pre-post CS differences, the data for the males will be presented first, to be followed by the data for the females.

The data in Fig. 3 indicates that, for Ss 2, the magnitude of performance decrement for RR during Shock condition increased as the complexity of the task increased. It should be noted that the pre-CS period during both Shock-baseline and Shock and the post-CS period during Shock-baseline were comparable. The comparability of these three time periods was anticipated since the experimental conditions under which these measures were obtained were similar. The above observation affords stronger evidence that the post-CS decrement during the Shock condition was attributable to the experimental procedures which differentiated the post-CS period during the Shock condition from the post-CS period during the Shock-baseline condition and the pre-CS period during the conditions of Shock-baseline and Shock.

Examination of Fig. 4 indicates that the same pattern across complexity levels was present for RL, and to a slight degree SPT, as was found with RR. For S2, as task complexity increased, the occurrence of the CS during the Shock condition was related to an increase in RL. For the most complex task, S2's RL was approximately 1/2 second longer during the period when the CS occurred.

The data for S3, as presented in Figs. 5 and 6, are similar to those of S2, with the exception that S3 showed some performance decrement during the 8-stimulus task. S3 showed an increase in RL and a decrease in RR relative to baseline as task complexity increased. The increase in SPT was greater for S3 than for S2, although here, too, the magnitude of the increase in SPT was small.

S4 exhibited the most performance decrement of all the Ss, as is evident in Figs. 7 and 8. The magnitude of the change was large for all three dependent variables, and performance decrement was present at all levels of task complexity. Whereas the other Ss showed a decrease in baseline RR and an increase in baseline RL and SPT as task complexity increased, S4 exhibited an increase in baseline RR and decrease in RL and SPT from the 8-stimulus task to the 16-stimulus task. His baseline levels for the 32-stimulus task were similar to his baselines on the 16-stimulus task. Thus, S4 showed a baseline pattern which differed from the patterns of the other Ss, this pattern consisting of an increase in RR

Fig. 3.--Mean response rate (RR) emitted during the pre- and post-CS periods by *S*2 during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

Each daily session consisted of 5 trials.

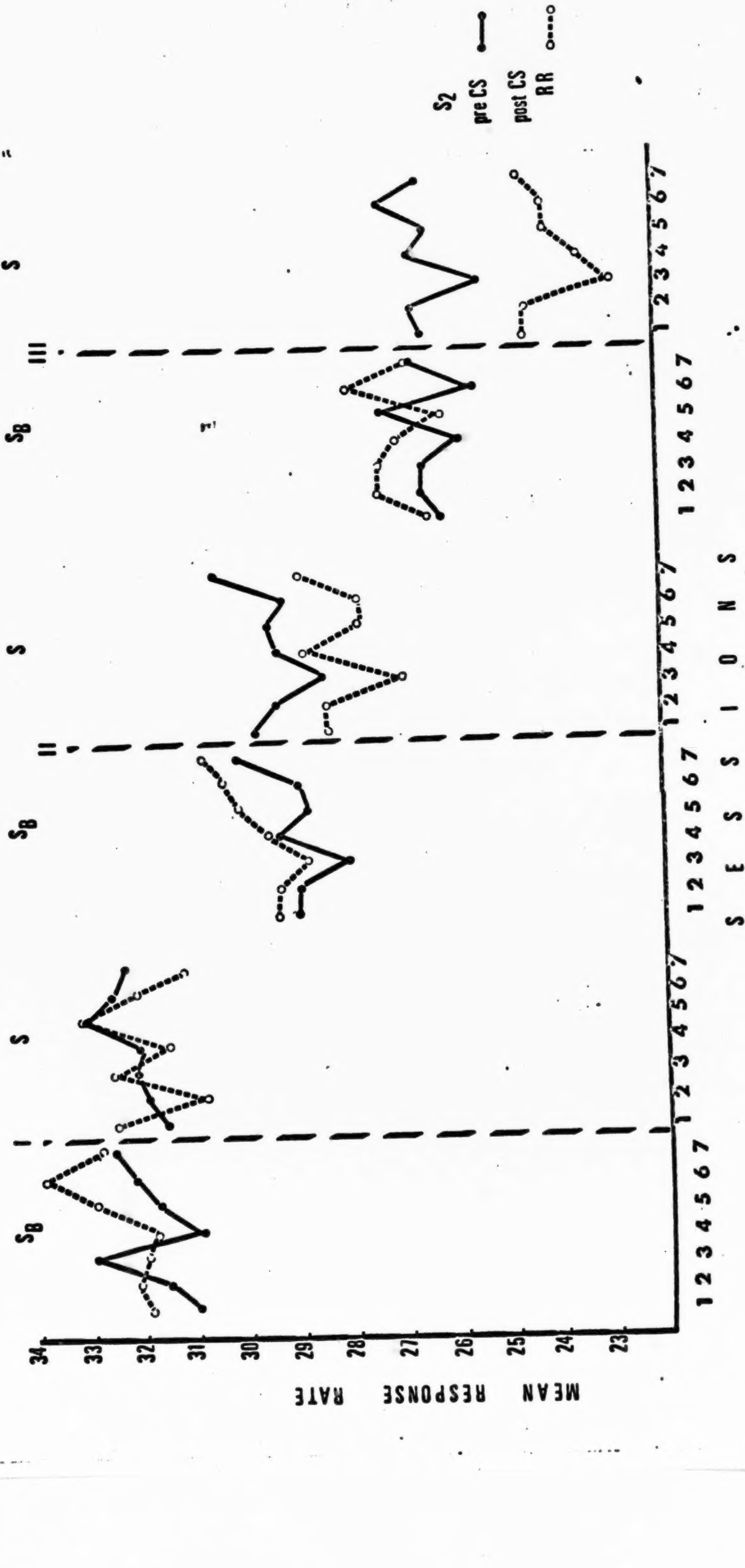
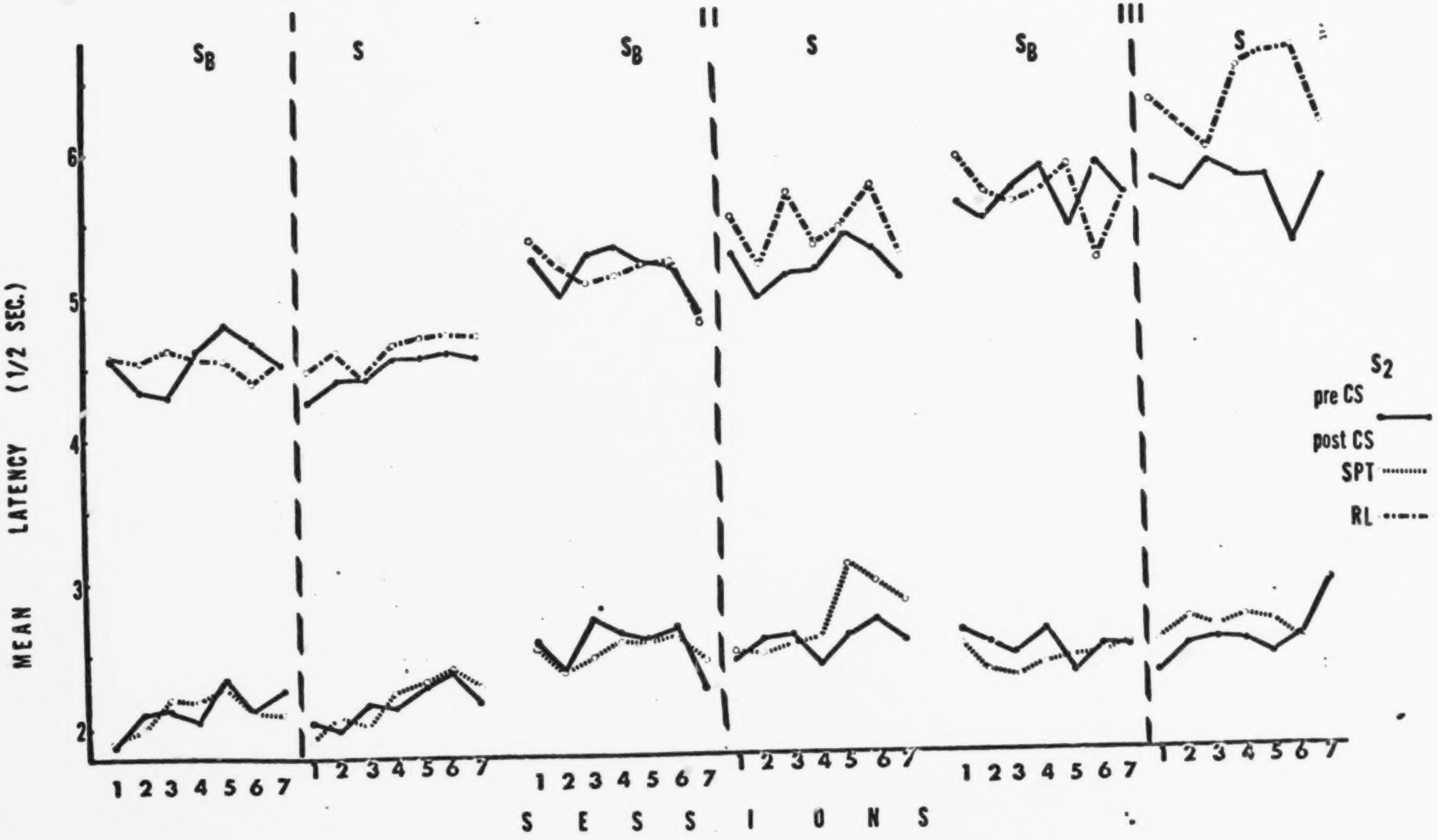

S_2
pre CS
post CS RR
S_B
I
S
S_B
II
S
S_B
III
S
MEAN RESPONSE RATE
34
33
32
31
30
29
28
27
26
25
24
23
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
SESSIONS

Fig. 4.--Mean response latency (RL) and stimulus presentation time (SPT) for *S*2 for pre- and post-CS trials during Shock-baseline (SB) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)


S₂
pre CS
post CS
SPT
RL
I
II
III
S_B
S
S_B
S
S_B
S
MEAN LATENCY (1/2 SEC.)
2
3
4
5
6
1 2 3 4 5 6 7
S E S S I O N S

and a decrease in RL as task complexity increased. For the 16- and 32-stimulus tasks, his RR was higher and his RL was shorter than those obtained by the other Ss. Examination of Figs. 7 and 8 indicates that, despite the different baseline pattern, the amount of performance decrement increased for the Shock condition as task complexity increased.

The individual data for the female Ss are presented in Figs. 9 and 10 (S5), 11 and 12 (S6), and 13 and 14 (S1). Ss 5 and 6 did not indicate any change in performance as a result of CER training. Although during the 16-stimulus task S5 appeared to show a slight facilitation, this was apparently a function of variability.

The data for S1, presented in Figs. 13 and 14, showed more variability than was present for any of the other Ss. S1 demonstrated response facilitation, as indicated by an increase in RR and a decrease in RL during post-CS periods when shock was administered. S1 also showed slower RL's and a lower RR than any of the other Ss. Fig. 13 indicates that on the second shock trial of the first session during the 8-stimulus task, only one response was emitted. The response pattern to CER training of S1 was directly opposite that shown by any of the other Ss. There was no indication that this pattern was related to task complexity. Although the magnitude of facilitation increased from the 8-stimulus task to the 16-stimulus task, the magnitude of facilitation for the 32-stimulus task was less than that obtained during the 16-stimulus task.

It is probable that the significant sex difference during baserate conditions for group data may have been due to the high RR of S4 and the low RR of S1, giving the males a higher mean RR than the females.

Consideration of individual Ss' data indicated that if a S demonstrated performance decrement, the magnitude of the decrement was related to the complexity of the task. Further evidence for this conclusion may be inferred from the data presented in Table 9. This table presents the F ratios for the condition x pre-post interaction obtained from individual S analyses of variance for each of the 3 levels of task complexity for the Shock-baseline-Shock comparison.

For RR, the F ratios increased as task complexity increased for Ss 2 and 3. For S4, the F ratios increased from the 8-stimulus task to the 16-stimulus task. Although the obtained F for the 32-stimulus task for S4 was less than that for the 16-stimulus task, it was still quite large relative to that obtained for the 8-stimulus task.

Fig. 5.--Mean response rate (RR) emitted during the pre- and post-CS periods by *S*3 during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

Each daily session consisted of 5 trials.

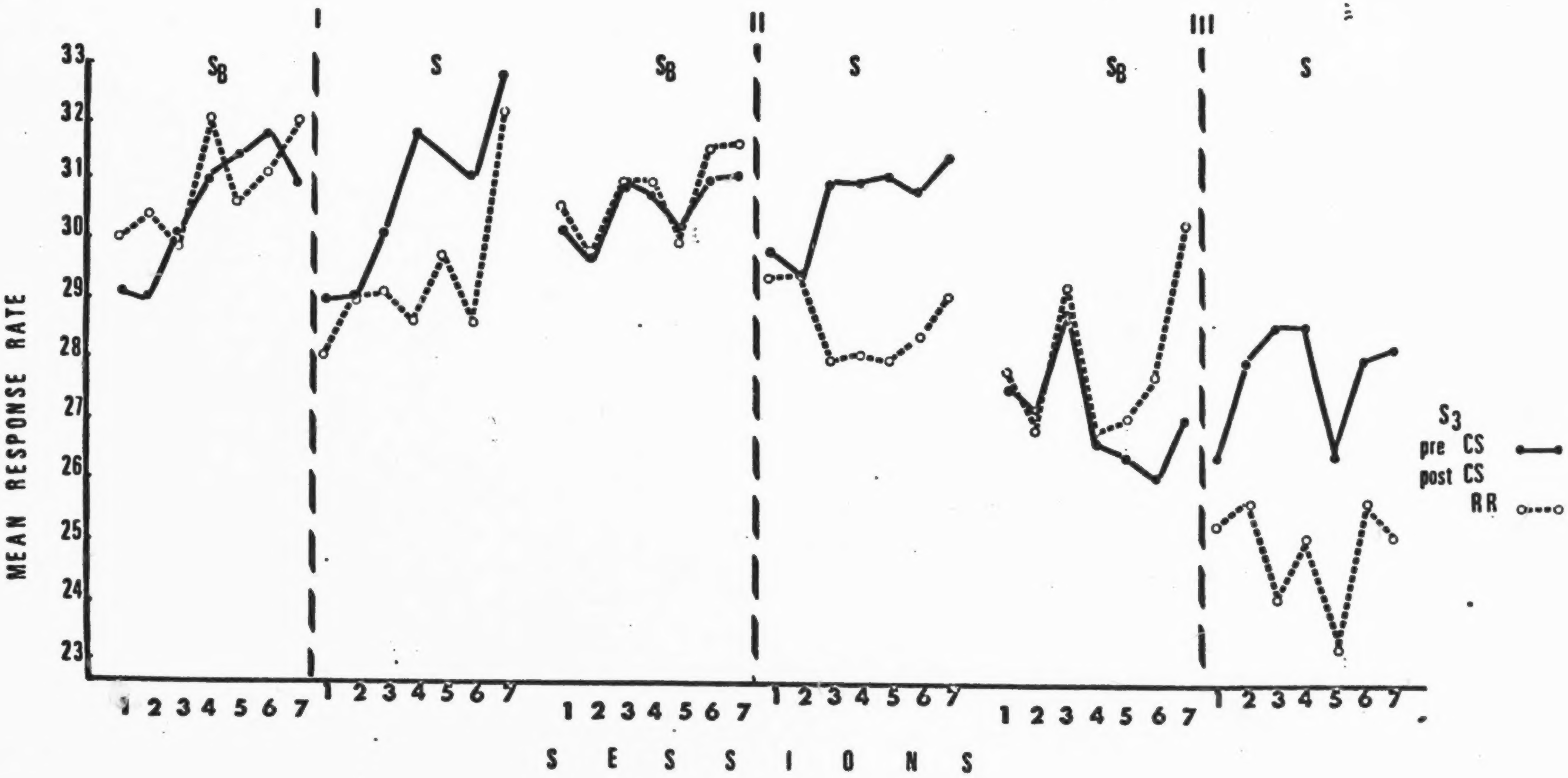

I
II
III
S_B
S
S_B
S
S_B
S
33
32
31
30
29
28
27
26
25
24
23
MEAN RESPONSE RATE
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
S E S S I O N S
S3
pre CS
post CS
RR

Fig. 6.--Mean response latency (RL) and stimulus presentation time (SPT) for S3 for pre- and post-CS trials during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

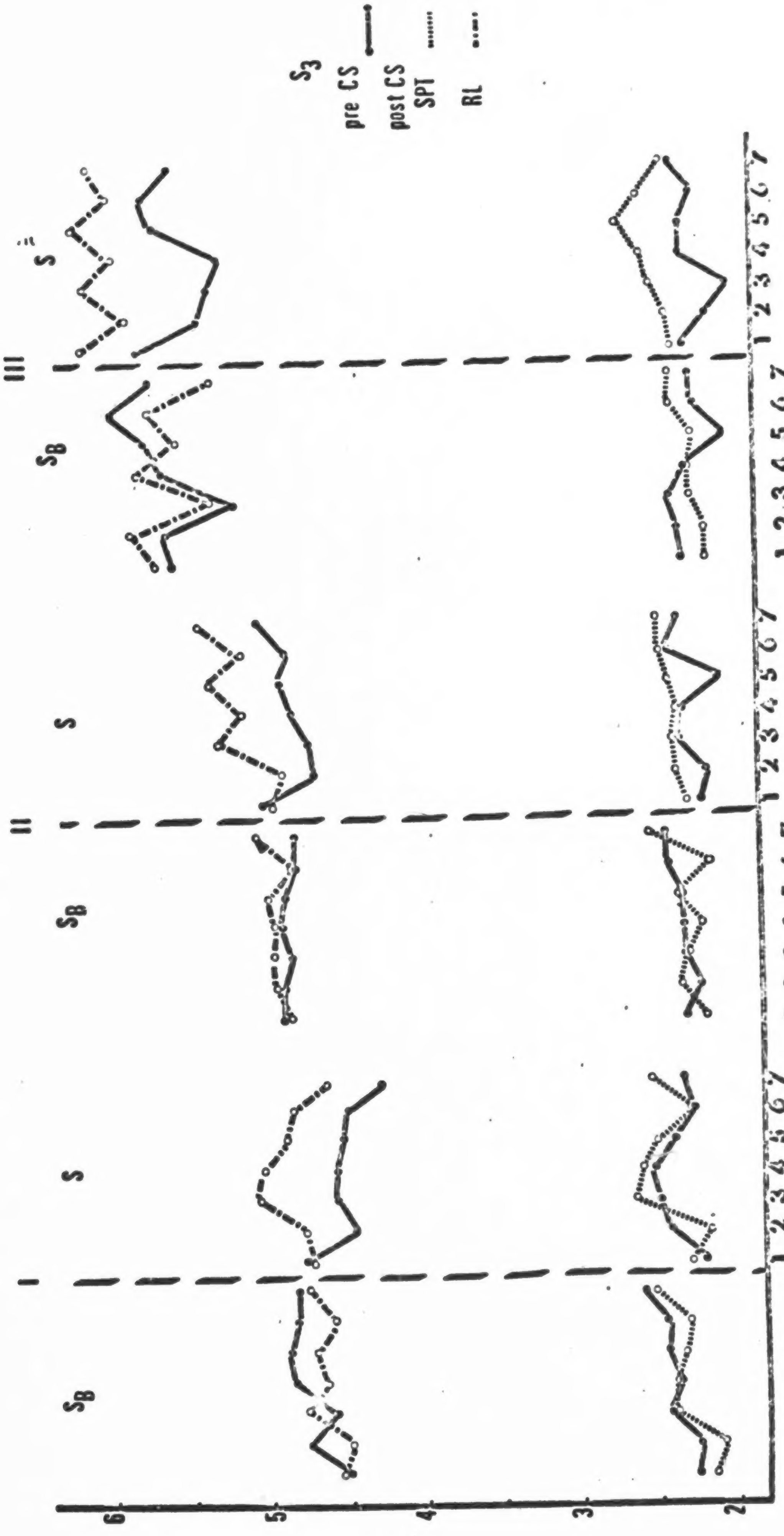

S3
pre CS
post CS
SPT
RL
SB
I
S
SB
II
S
SB
III
S
1 2 3 4 5 6 7
6
5
4
3
2
MEAN LATENCY (1/2 SEC.)
SESSIONS

Fig. 7.--Mean response rate (RR) emitted during the pre- and post-CS periods by *S*4 during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

Each daily session consisted of 5 trials.

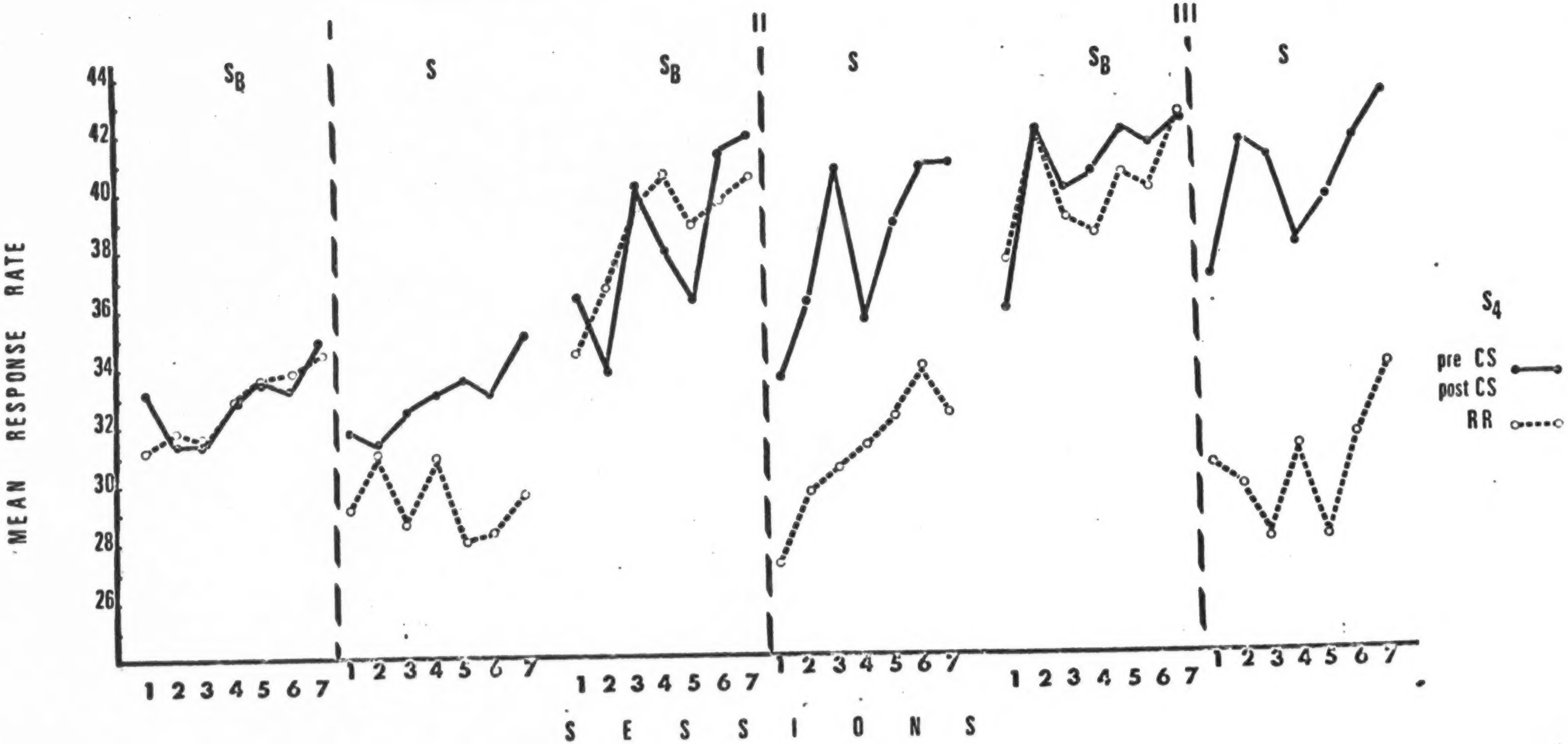

S₄
pre CS
post CS
RR
MEAN RESPONSE RATE
44
42
40
38
36
34
32
30
28
26
S_B
S
S_B
S
S_B
S
I
II
III
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
SESSIONS

Fig. 8.--Mean response latency (RL) and stimulus presentation time (SPT) for S4 for pre- and post-CS trials during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

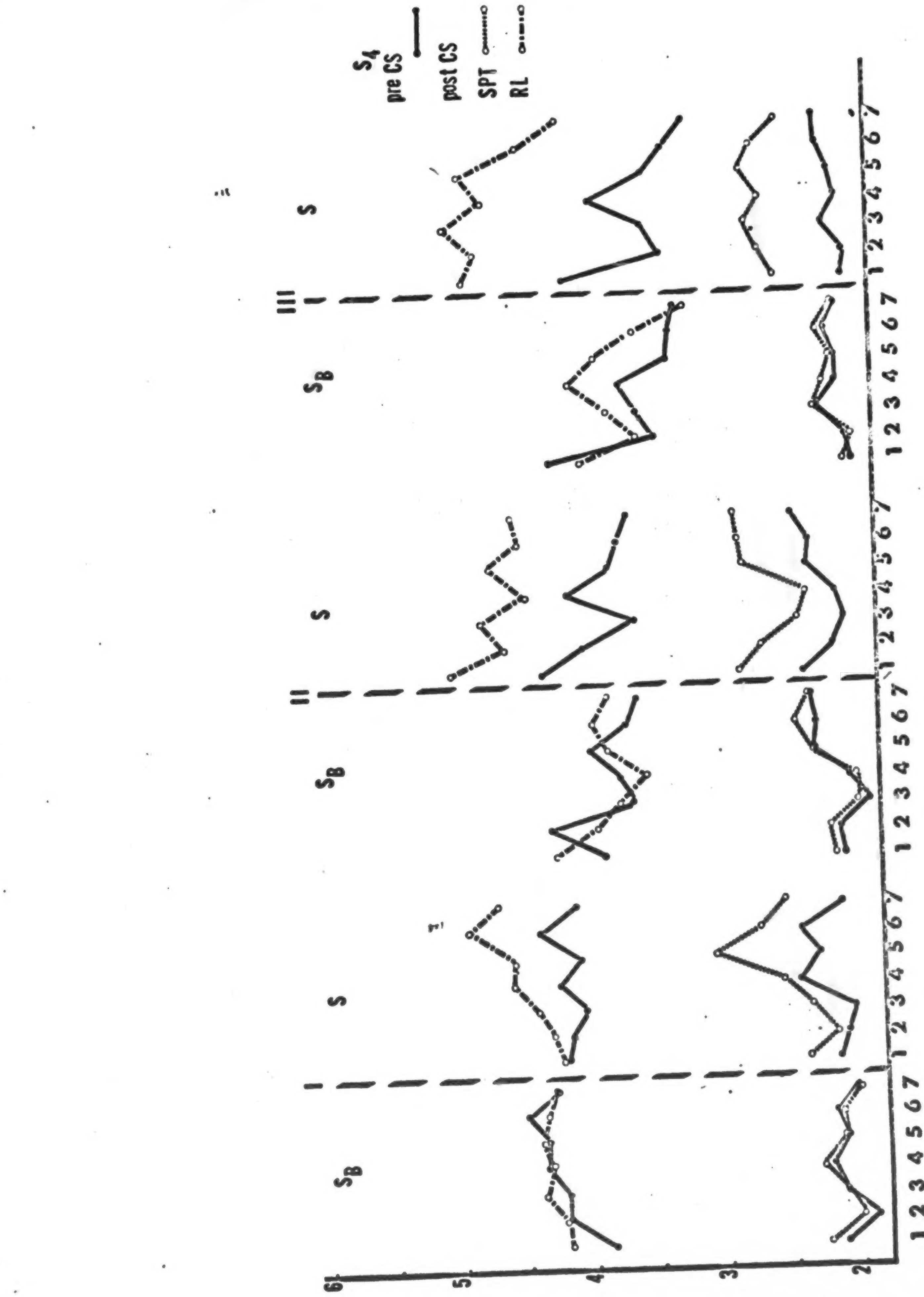

S4
pre CS
post CS
SPT
RL
MEAN LATENCY (1/2 SEC.)
6
5
4
3
2
SB
S
SB
S
SB
S
II
III
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
SESSIONS

Fig. 9.--Mean response rate (RR) emitted during the pre- and post-CS periods by *S*5 during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

Each daily session consisted of 5 trials.

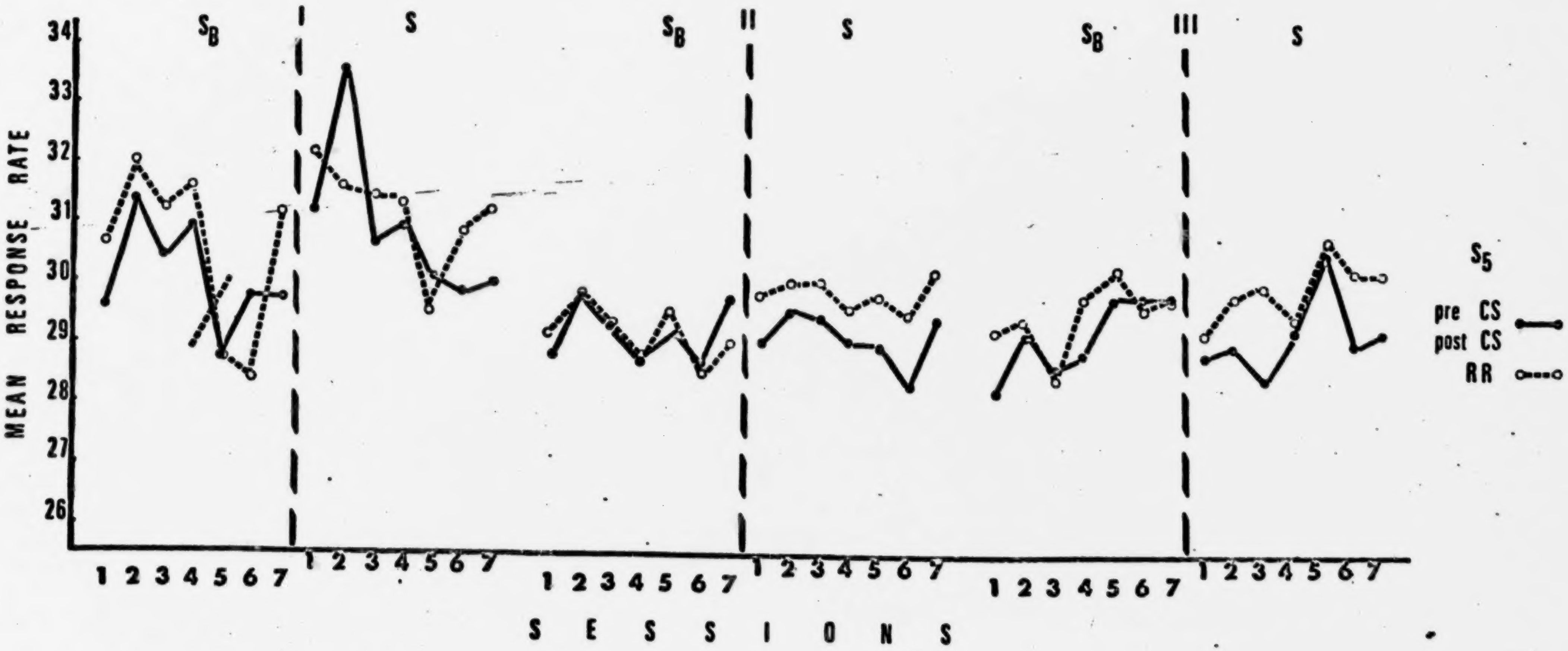

MEAN RESPONSE RATE
34
33
32
31
30
29
28
27
26
S_B
I
S
S_B
II
S
S_B
III
S
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
SESSIONS
S_5
pre CS
post CS
RR

Fig. 10.--Mean response latency (RL) and stimulus presentation time SPT) for S5 for pre- and post-CS trials during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II - 16-stimulus task, and Level III = 32-stimulus task.)

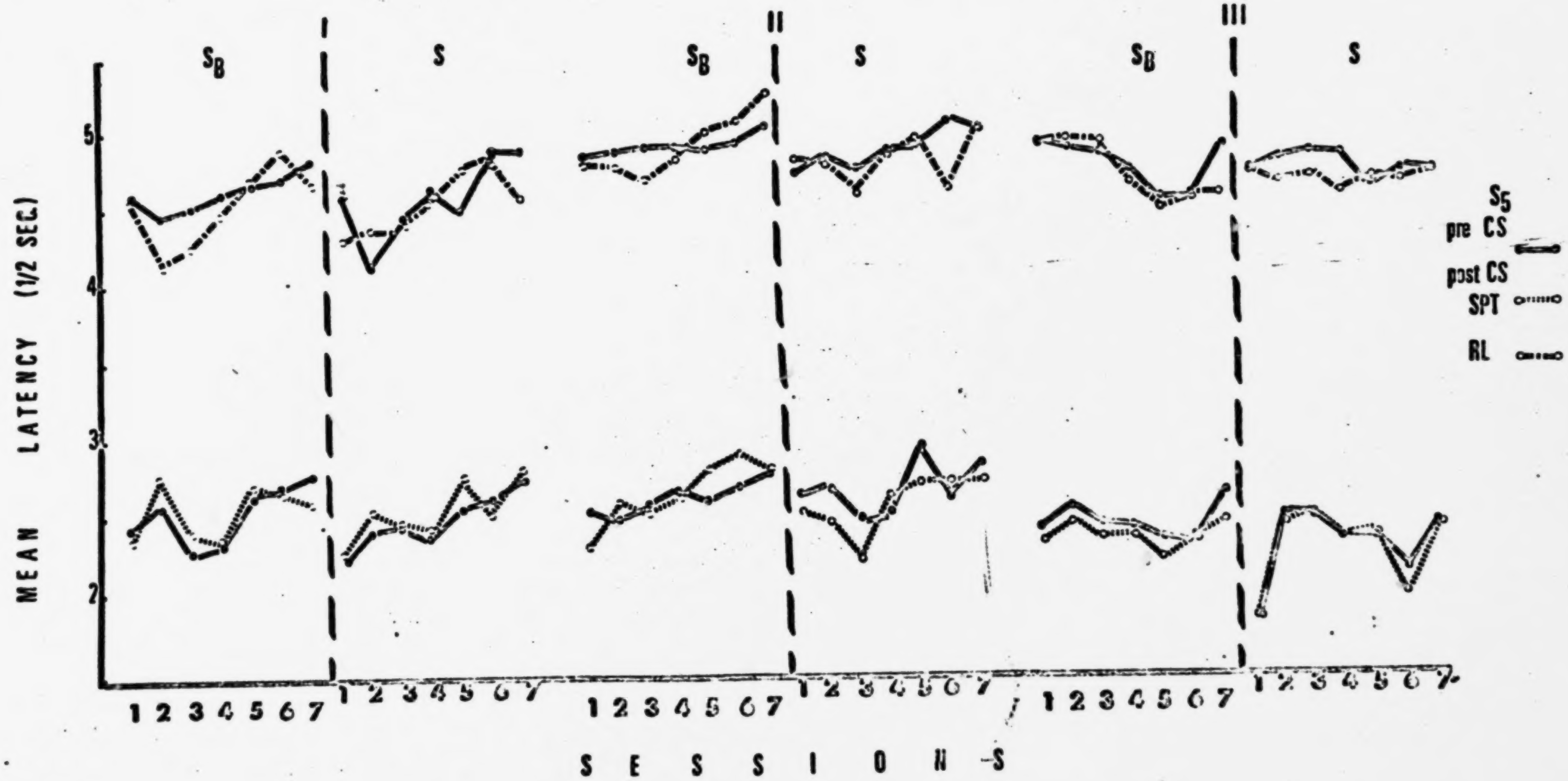

MEAN LATENCY (1/2 SEC.)
5
4
3
2
S_B
S
S_B
II
S
S_B
III
S
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
SESSIONS
S_5
pre CS
post CS
SPT
RL

Fig. 11.--Mean response rate (RR) emitted during the pre- and post-CS periods by *S*6 during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

Each daily session consisted of 5 trials.

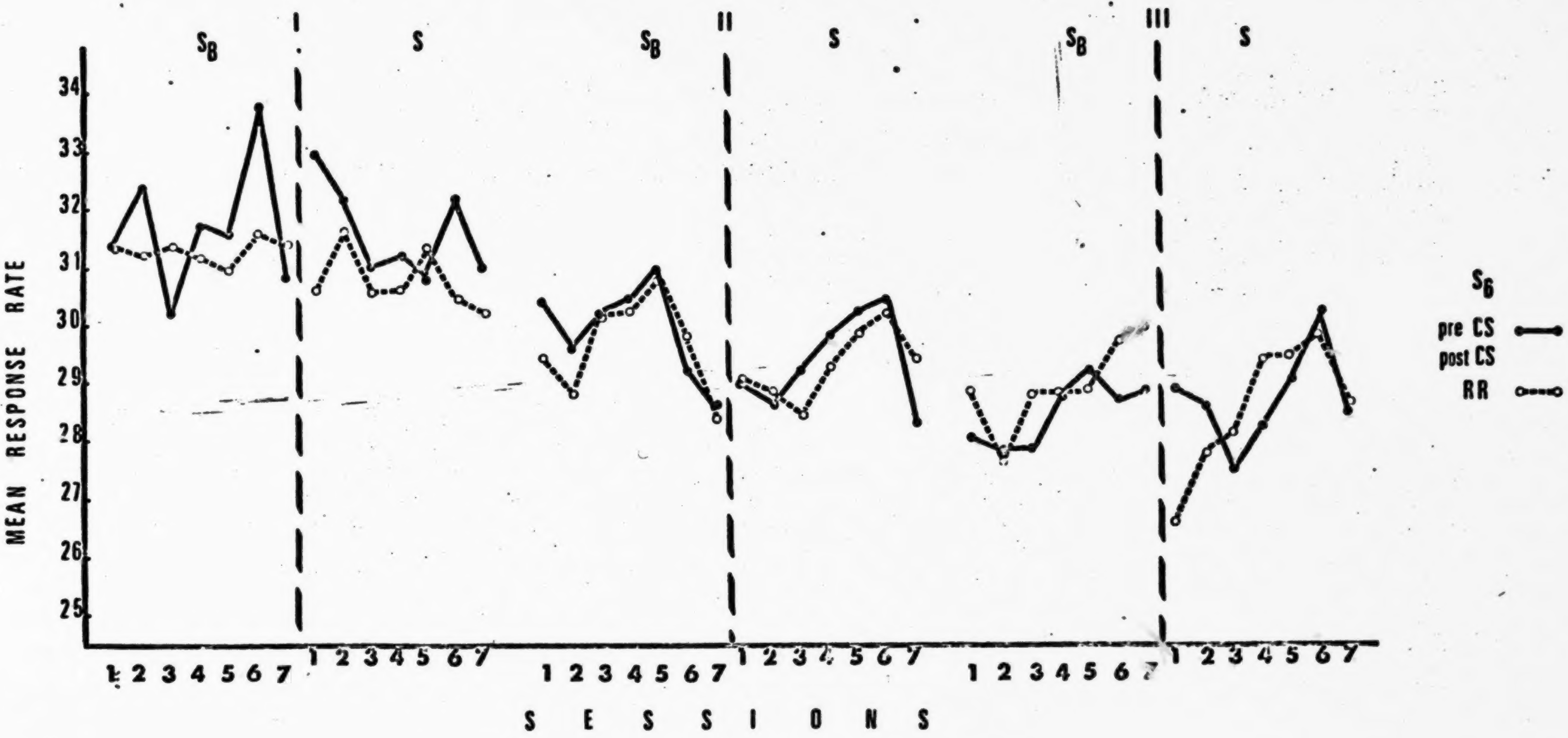

S_B
I
S
S_B
II
S
S_B
III
S
34
33
32
31
30
29
28
27
26
25
MEAN RESPONSE RATE
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
S E S S I O N S
S6
pre CS
post CS
RR

Fig. 12.--Mean response latency (RL) and stimulus presentation time (SPT) for S6 for pre- and post-CS trials during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

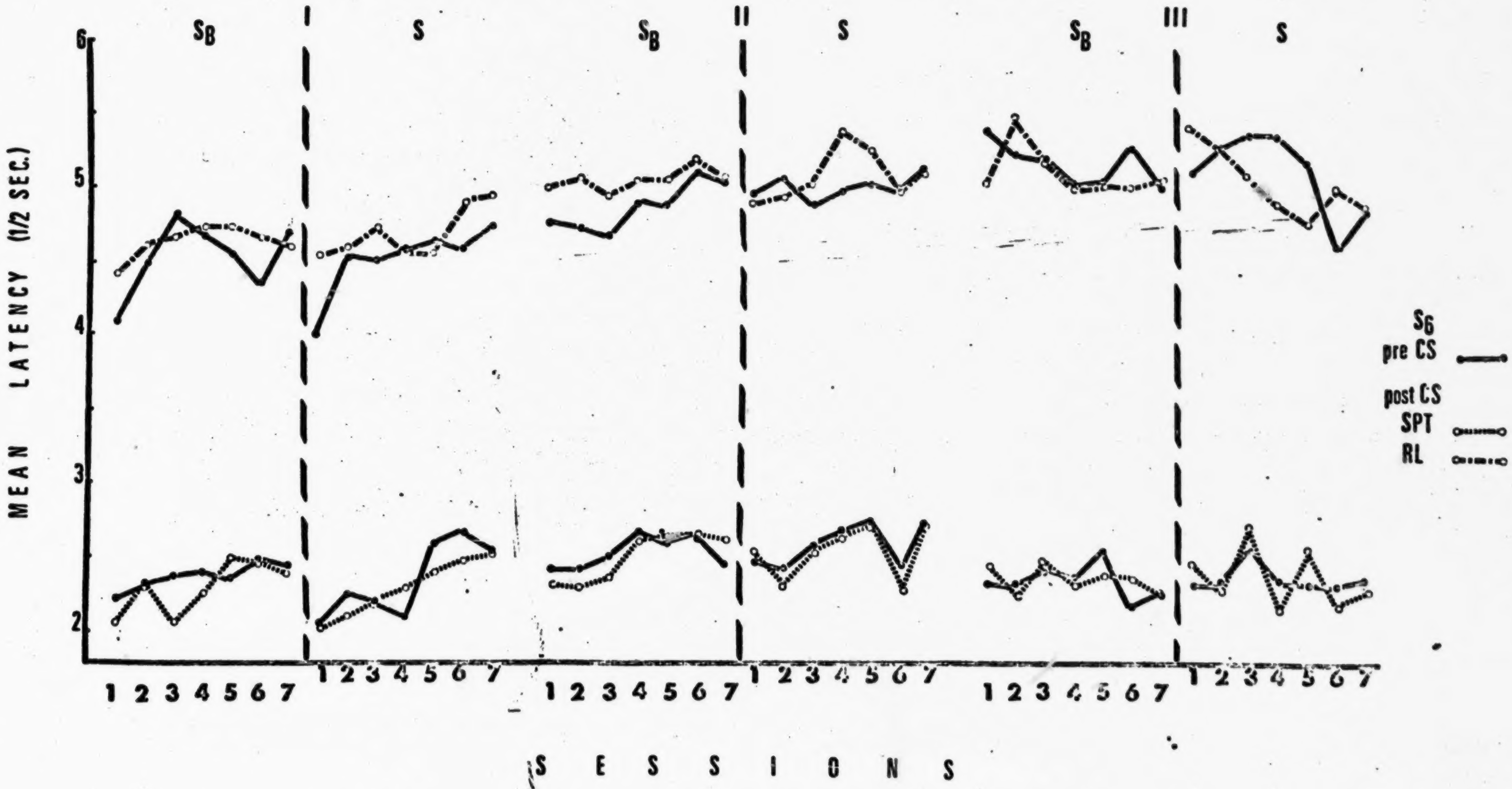

S_B
I
S
S_B
II
S
S_B
III
S
MEAN LATENCY (1/2 SEC.)
6
5
4
3
2
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
S E S S I O N S
S6
pre CS
post CS
SPT
RL

Fig. 13.--Mean Response rate (RR) emitted during the pre- and post-CS periods by *S*1 during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

Each daily session consisted of 5 trials.

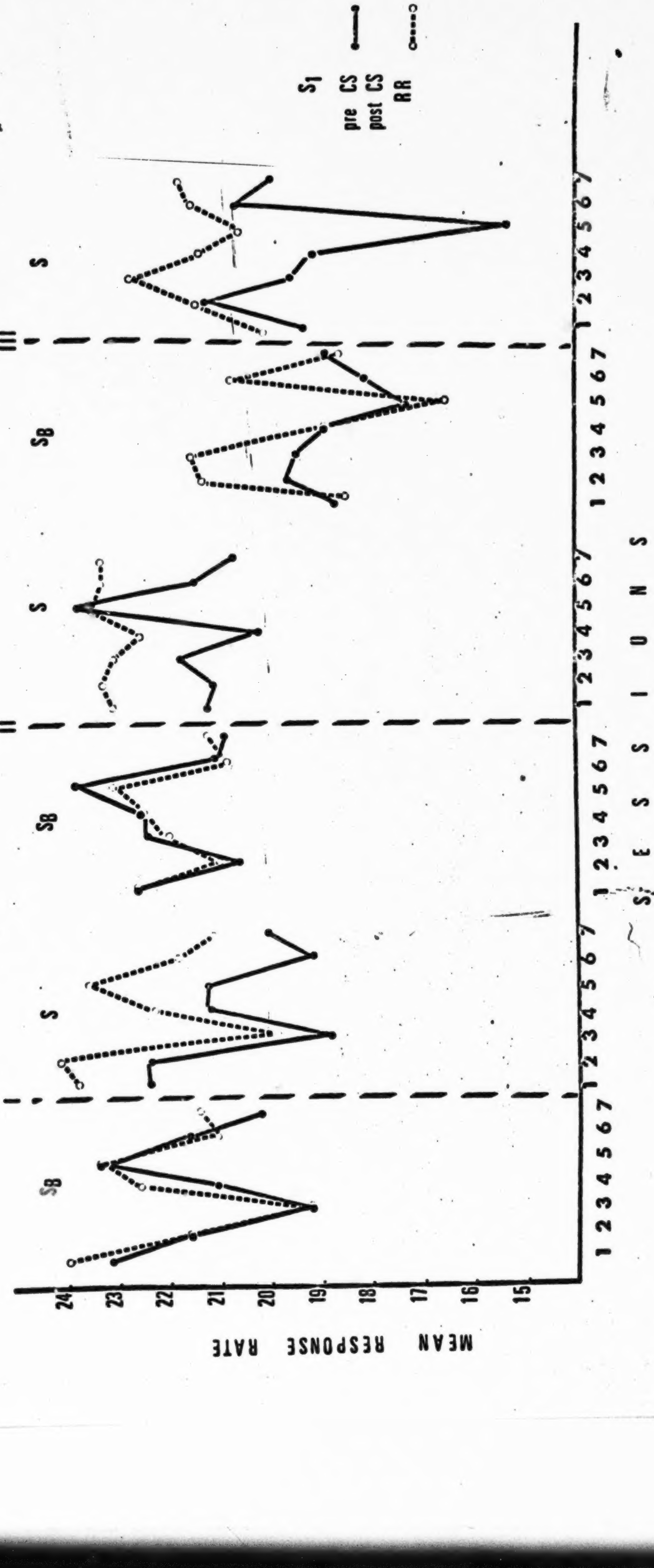
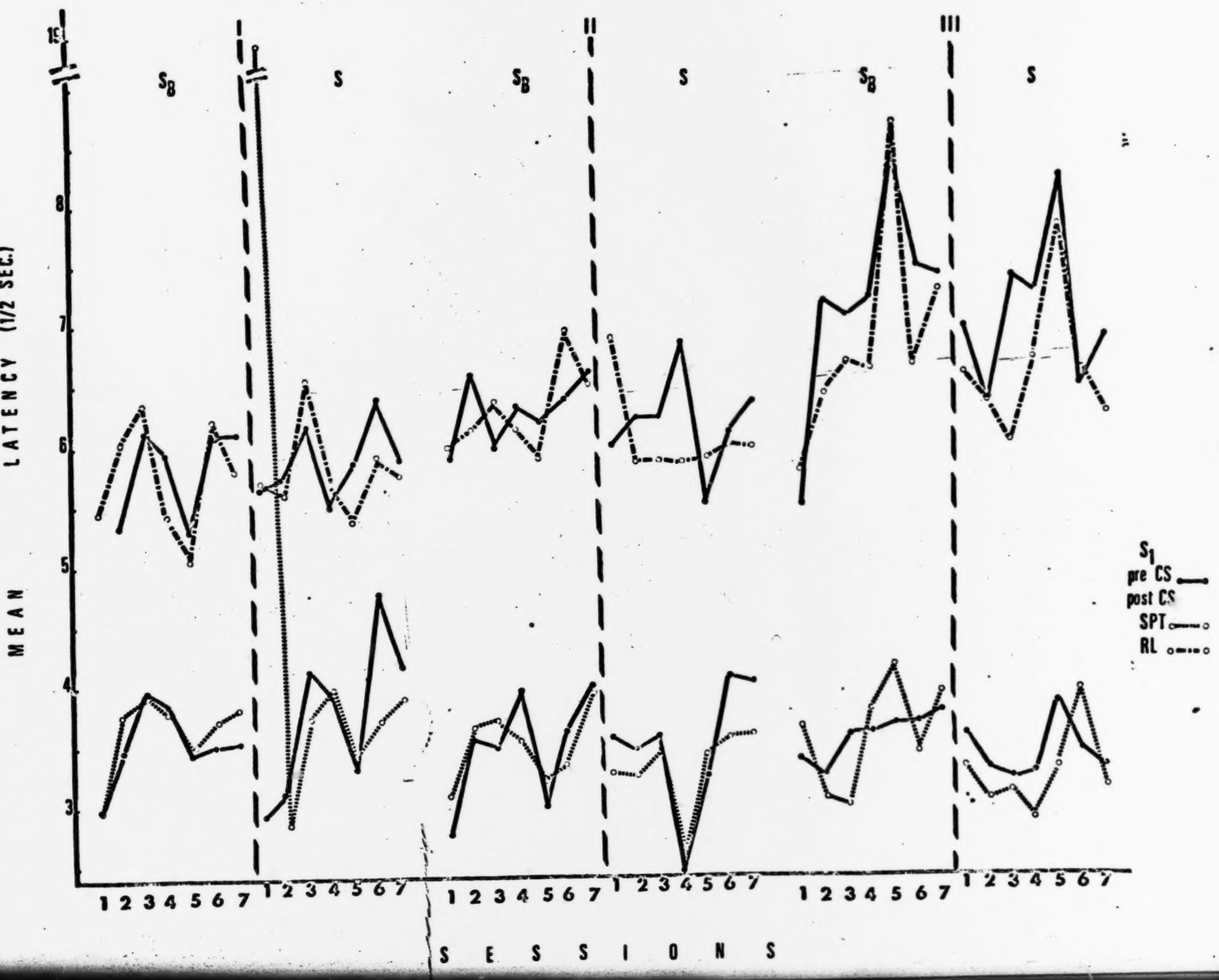

S1
pre CS
post CS
RR
SB
S
SB
S
SB
S
II
III
MEAN RESPONSE RATE
24
23
22
21
20
19
18
17
16
15
SESSIONS
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7

Fig. 14.--Mean response latency (RL) and stimulus presentation time (SPT) for S1 for pre- and post-CS trials during Shock-baseline (S_B) and Shock (S) conditions for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)


MEAN LATENCY (1/2 SEC.)
19
8
7
6
5
4
3
I
II
III
S_B
S
S_B
S
S_B
S
1 2 3 4 5 6 7
S E S S I O N S
S1
pre CS
post CS
SPT
RL

The F ratios for S5 indicated that the CER procedure produced no significant change at any of the complexity levels. Therefore, the effect indicated in Fig. 9 was not statistically significant. S6 had a significant F for RR for the 16-stimulus task but examination of Fig. 11 indicates that the magnitude of this effect was small. The overlapping of the pre- and post-CS curves indicates that this suppression was not a consistent effect.

Analysis of the S1 data indicated that the facilitation of RR was significant for the 16- and 32-stimulus task, although the magnitude of the F ratio decreased from the 16- to the 32-stimulus task.

For male Ss, analysis of RL indicated patterns similar to those found for RR. The observation that Ss 5 and 6 did not obtain significant F ratios for RL supports the notion that the separation in Fig. 9, and to a lesser extent in Fig. 11, was due to the variability in RR and not to any consistent change in performance.

For SPT, male Ss indicated an increase in SPT as task complexity increased. No changes were noted in SPT with females.

To determine whether the significant effects were due to the CER procedure, similar individual analyses were computed between Baseline and Shock-baseline conditions. None of these were significant, indicating that the increasing magnitude of F ratios was due to both the CER procedure and the increase in task complexity.

CER Ratios

The following section depicts the pattern of the previously presented data when converted to CER ratios using the formula (A-B)/(A+B). When this ratio is negative it indicates that the magnitude of the dependent variable in the post-CS period (B) was greater than during the pre-CS period (A). Positive ratios indicate that the magnitude decreased during period B relative to period A.

Fig. 15 presents the CER ratios for S2. The baseline for all 3 dependent variables fluctuated around zero. This observation was to be expected if no difference between pre- and post-CS periods was found. During the Shock condition, as task complexity increased, the ratio for RR increased positively while the ratio for RL increased negatively. Visual inspection of the CER ratios for S2 indicates that the shock procedure produced a consistent change in performance as task complexity increased. However,

TABLE 9

SUMMARY OF CONDITION X PRE-POST INTERACTION FROM ANALYSES OF VARIANCE FOR INDIVIDUAL SUBJECTS AT EACH LEVEL OF TASK COMPLEXITY FOR THE SHOCK-BASELINE - SHOCK CONDITION

Subjects	Level of Task Complexity	Stimulus Presentation Time	Response Latency	Response Rate
	1	.727	.991	.147
S1	2	1.881	3.838	9.348**
	3	2.930	1.352	4.831*
	1	1.110	3.014	6.006*
S2	2	8.040**	5.296*	36.850**
	3	9.203**	23.983**	45.873**
	1	6.370*	12.448**	21.949**
S3	2	12.239**	9.274**	36.444**
	3	11.107**	28.870**	39.218**
	1	11.527**	9.257**	28.372**
S4	2	23.867**	33.781**	68.135**
	3	42.074**	33.350**	51.291**
	1	1.283	.272	2.049
S5	2	1.693	2.383	.284
	3	.063	.014	1.038
	1	.506	.478	.485
S6	2	2.215	.253	12.286**
	3	1.063	.061	1.243

** = $p < .01$
* = $p < .05$

the magnitudes of the ratios were small compared to those typically obtained from other species. Although the maximum ratio for RR was less than .10, the stability of baseline ratios allowed for the observation of a definite change following CS onset.

The ratios in Fig. 16 indicate that S3 showed results similar to those shown by S2, except that those of S3 were more marked. Both Ss 2 and 3 showed little change during the 8-stimulus task and substantially more change as task complexity increased.

S4, as Fig. 17 indicates, showed the greatest magnitude of change, with CER ratios as large as -.20 for RL and .18 for RR. As task complexity increased, S4 demonstrated an increase in RR and a decrease in SPT and RL. Conversion of these data to suppression ratios allowed for the equating of different magnitudes to a common factor. Thus, for S4, the baseline increase in RR and decrease in RL that occurred as task complexity increased, did not appear when his data were expressed in ratio form. Comparison of Fig. 17 with Figs. 15, 16, 18, 19, and 20 indicates that of all the Ss, S4 showed the greatest change from baseline.

The ratios for S5 (Fig. 18) and S6 (Fig. 19) failed to indicate any consistent change as a function of CER procedures. Although S6 appeared to indicate some facilitation of RL during the 32-stimulus task, this was probably due to random variability since the change was not consistent and overlap with baseline was present. In addition, none of the other methods of examining these data has yielded any significant effect for S6 for RL during the 32-stimulus task.

A comparison of the CER ratios of S1 (Fig. 20) with the ratios of the other Ss (Figs. 15 - 19) indicates that S1 produced more variability than the other Ss. The amount of variability, as evidenced by the irregular cross-overs in Fig. 20, implies that the facilitation shown by S1 was not a consistent effect. While the data for S1 implied facilitation of RR for the 16- and 32-stimulus tasks, there was no corresponding change in RL. If the relative amount of time per response was unchanged, then the appearance of response facilitation was probably due to a change in the variability of the response distribution rather than due to a consistent increase in the rate of responding.

Fig. 21 indicates the number of responses for successive 15-second periods for each of the six Ss during Shock-baseline and Shock conditions. The period from 0 to 45" was the pre-CS interval, while the period from 45" to 90" was the post-CS period. For Ss 2, 3, and 4, the rate

Fig. 15.--Mean CER ratios for response rate (RR), response latency (RL), and stimulus presentation time (SPT) for S2 for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.

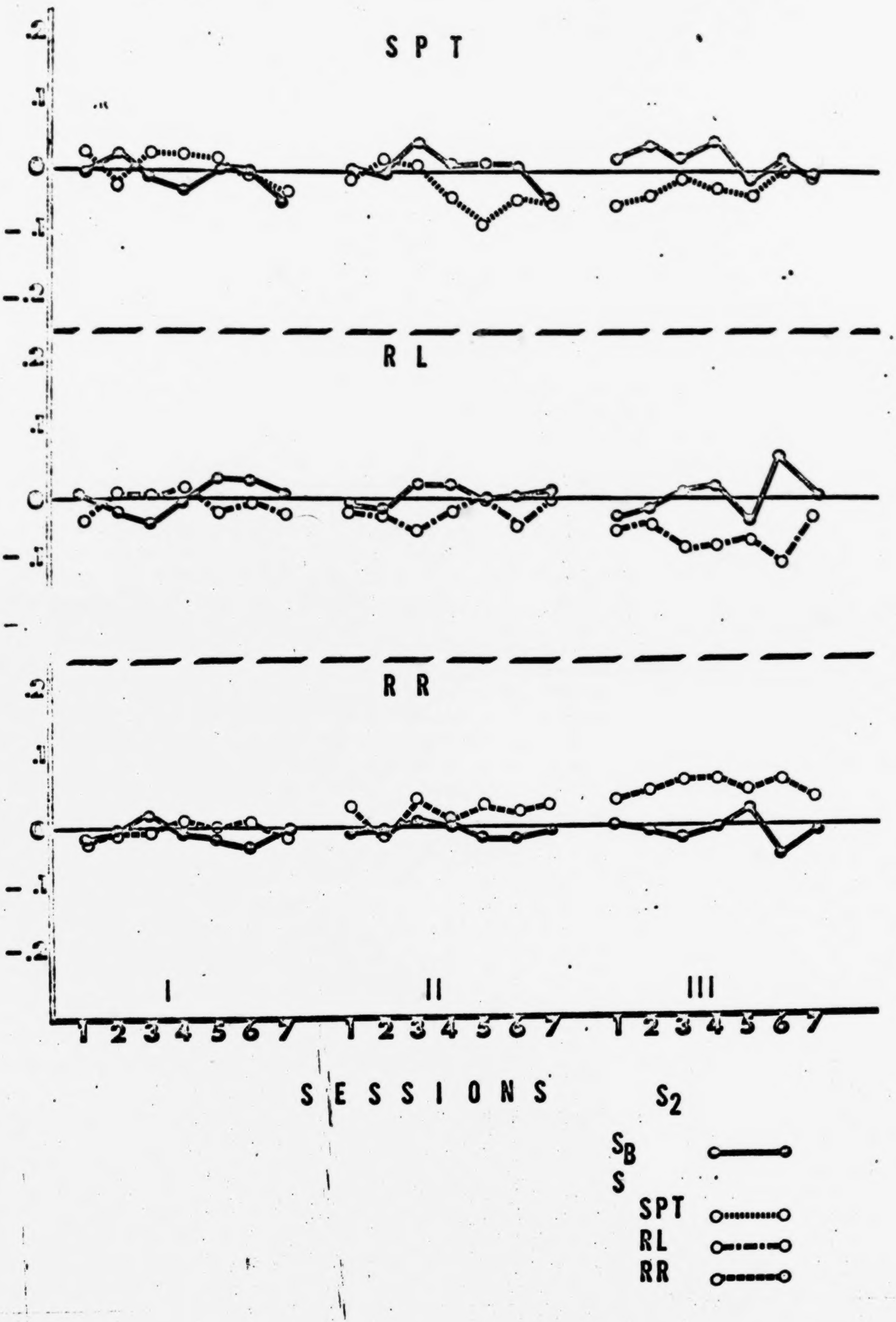

SPT
RL
RR
MEAN CER RATIO
.2
.1
0
-.1
-.2
I
II
III
1 2 3 4 5 6 7
SESSIONS
S2
S_B
S
SPT
RL
RR

Fig. 16.--Mean CER ratios for response rate (RR), response latency (RL), and stimulus presentation time (SPT) for S3 for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

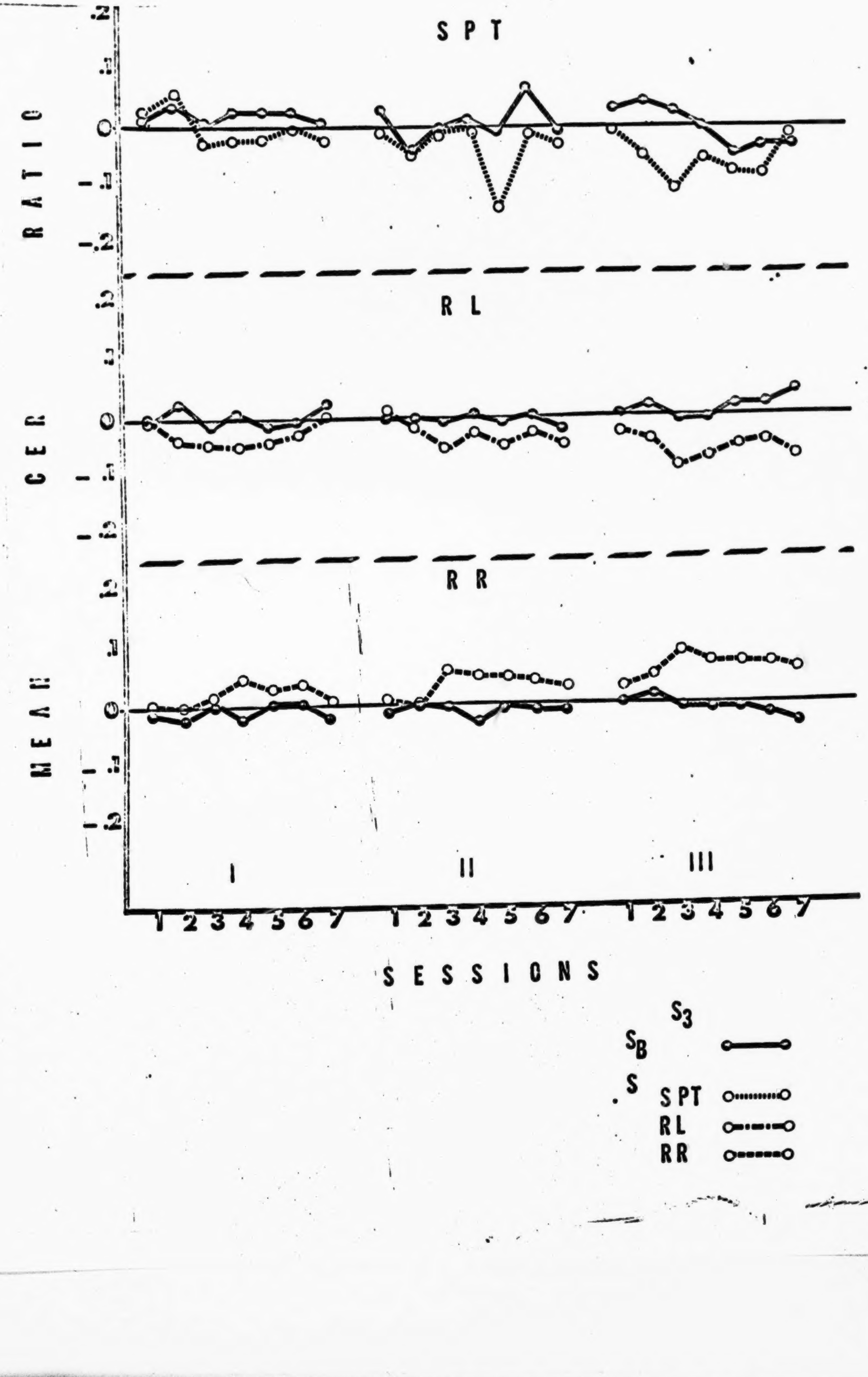

SPT
RL
RR
MEAN CER RATIO
.2
.1
0
-.1
-.2
I
II
III
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
SESSIONS
S3
SB
S
SPT
RL
RR

Fig. 17.--Mean CER ratios for response rate (RR), response latency (RL), and stimulus presentation time (SPT) for S4 for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

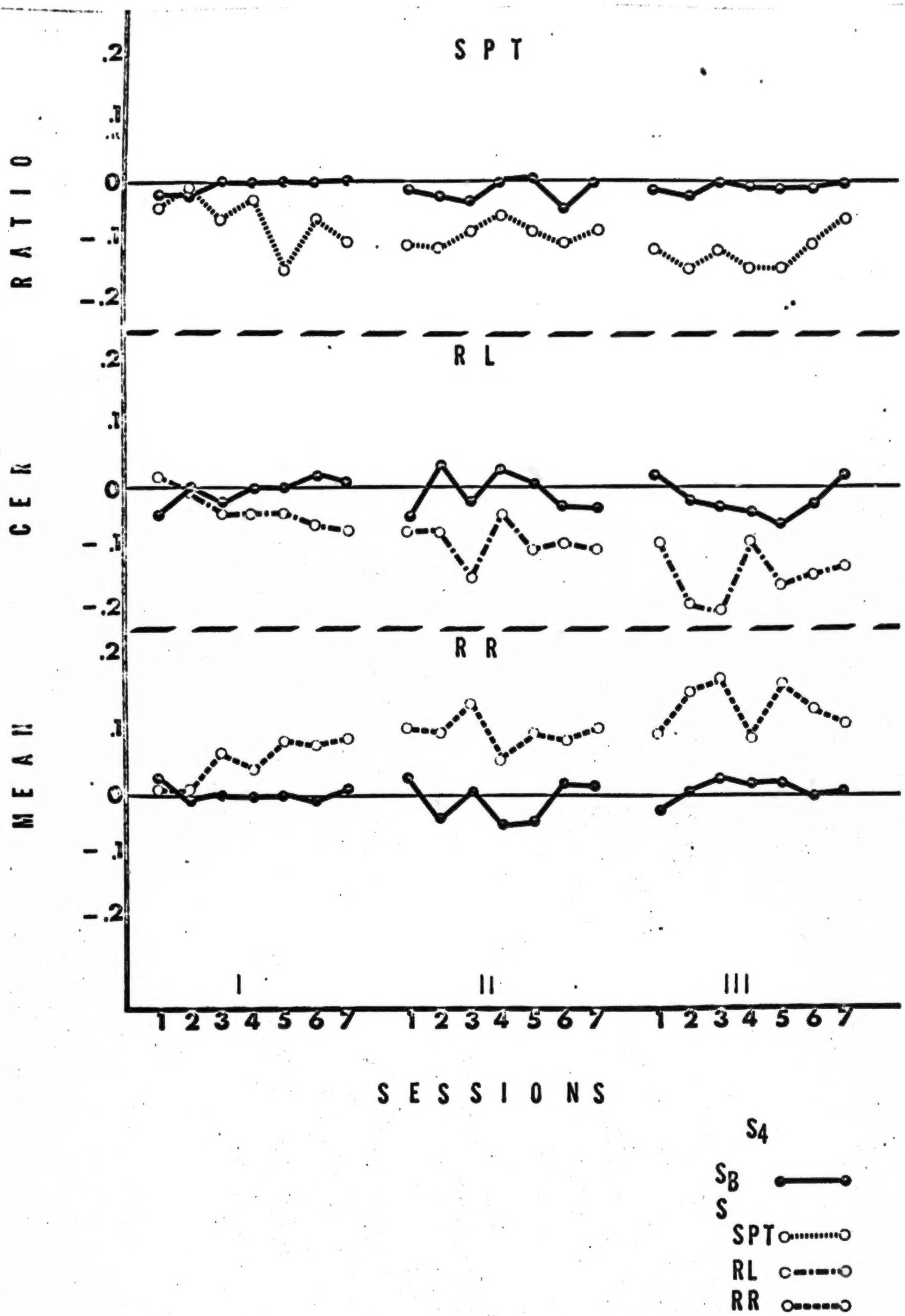

S P T
R L
R R
RATIO
CER
MEAN
.2
.1
0
-.1
-.2
I
II
III
1 2 3 4 5 6 7
SESSIONS
S4
S_B
S
SPT
RL
RR

Fig. 18.--Mean CER ratios for response rate (RR), response latency (RL), and stimulus presentation time (SPT) for S5 for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

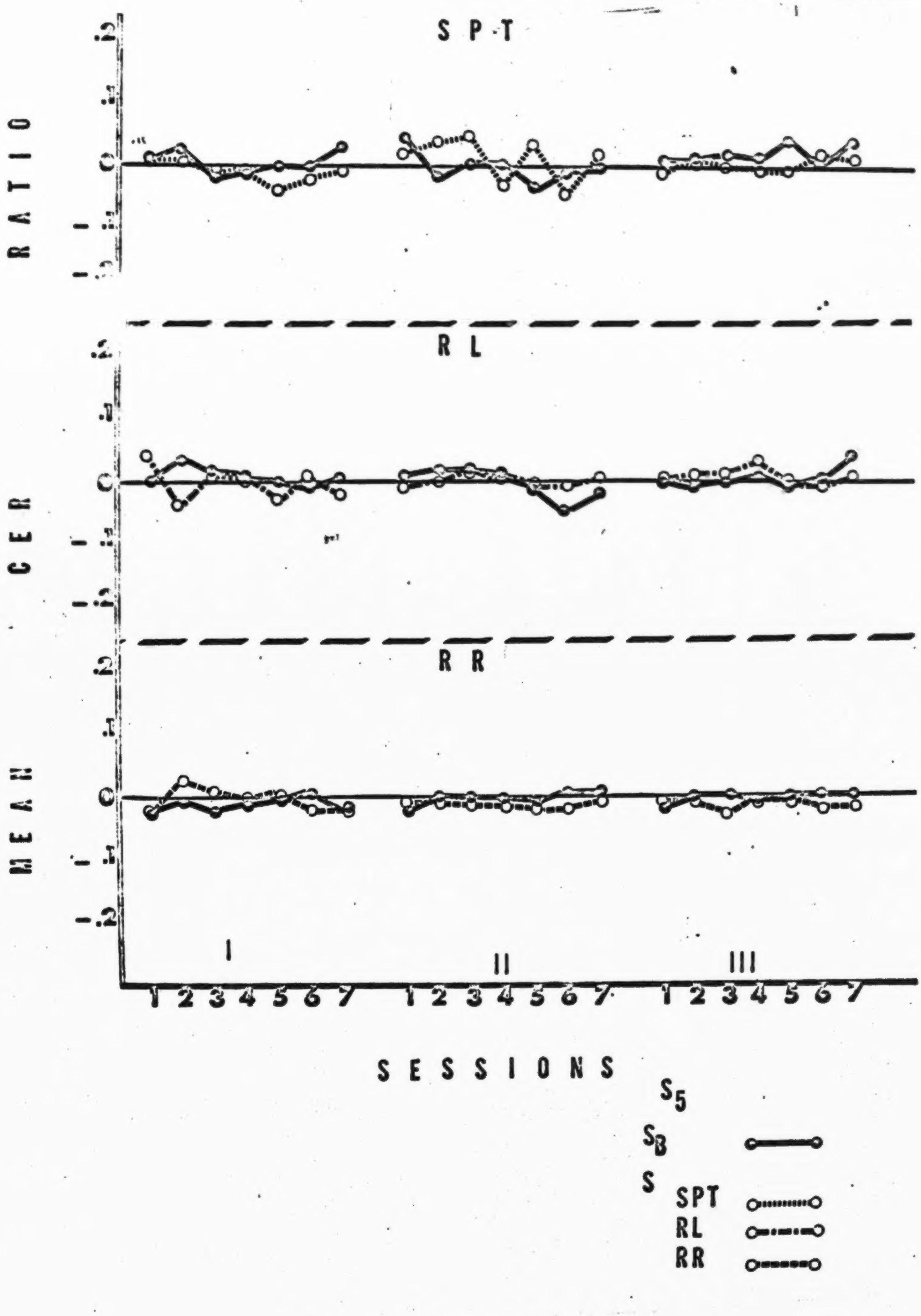

S P T
R L
R R
MEAN CER RATIO
.2
.1
0
-.1
-.2
SESSIONS
I
II
III
1 2 3 4 5 6 7
S_5
S_B
S
SPT
RL
RR

Fig. 19.--Mean CER ratios for response rate (RR), response latency (RL), and stimulus presentation time (SPT) for S6 for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)

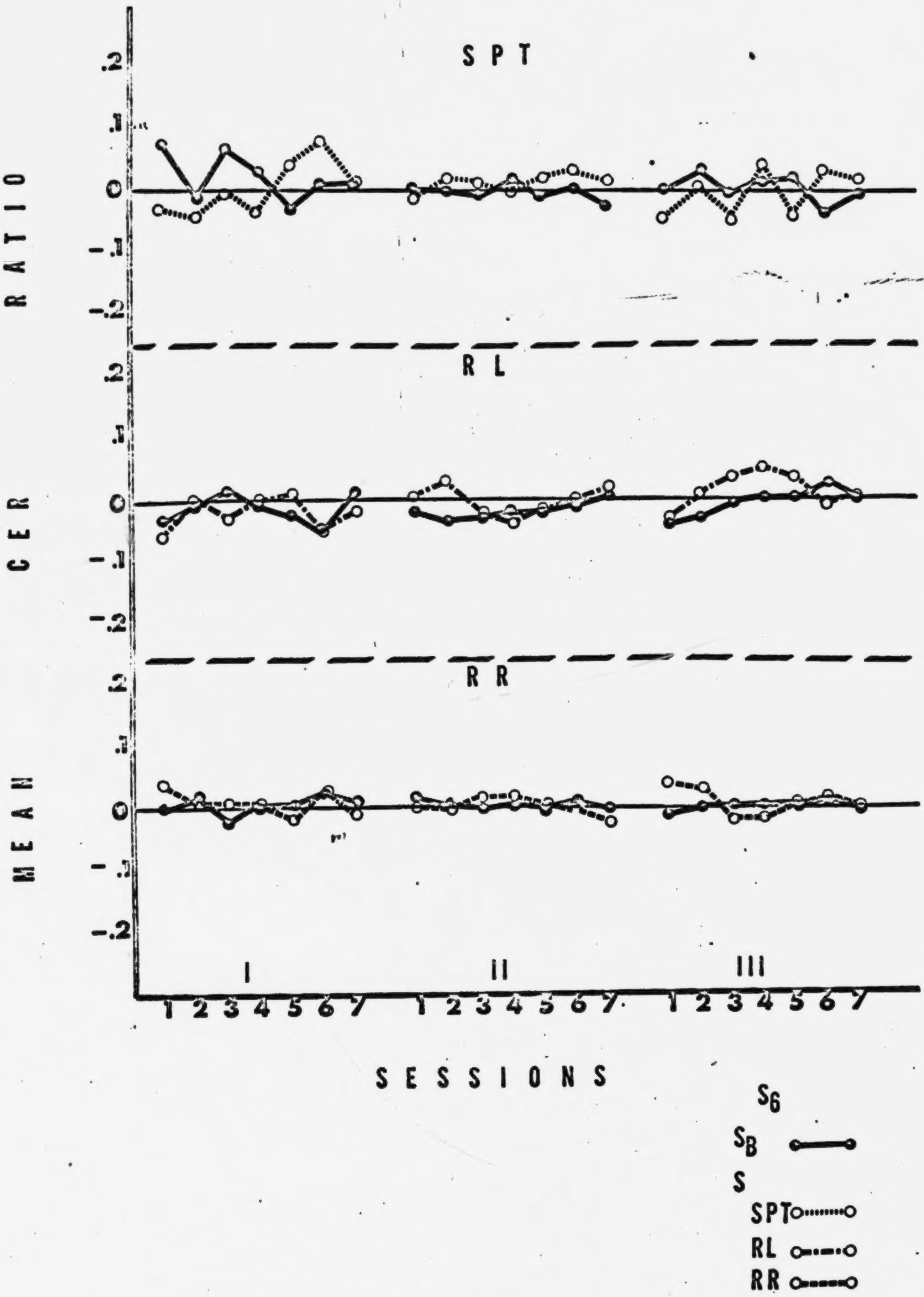
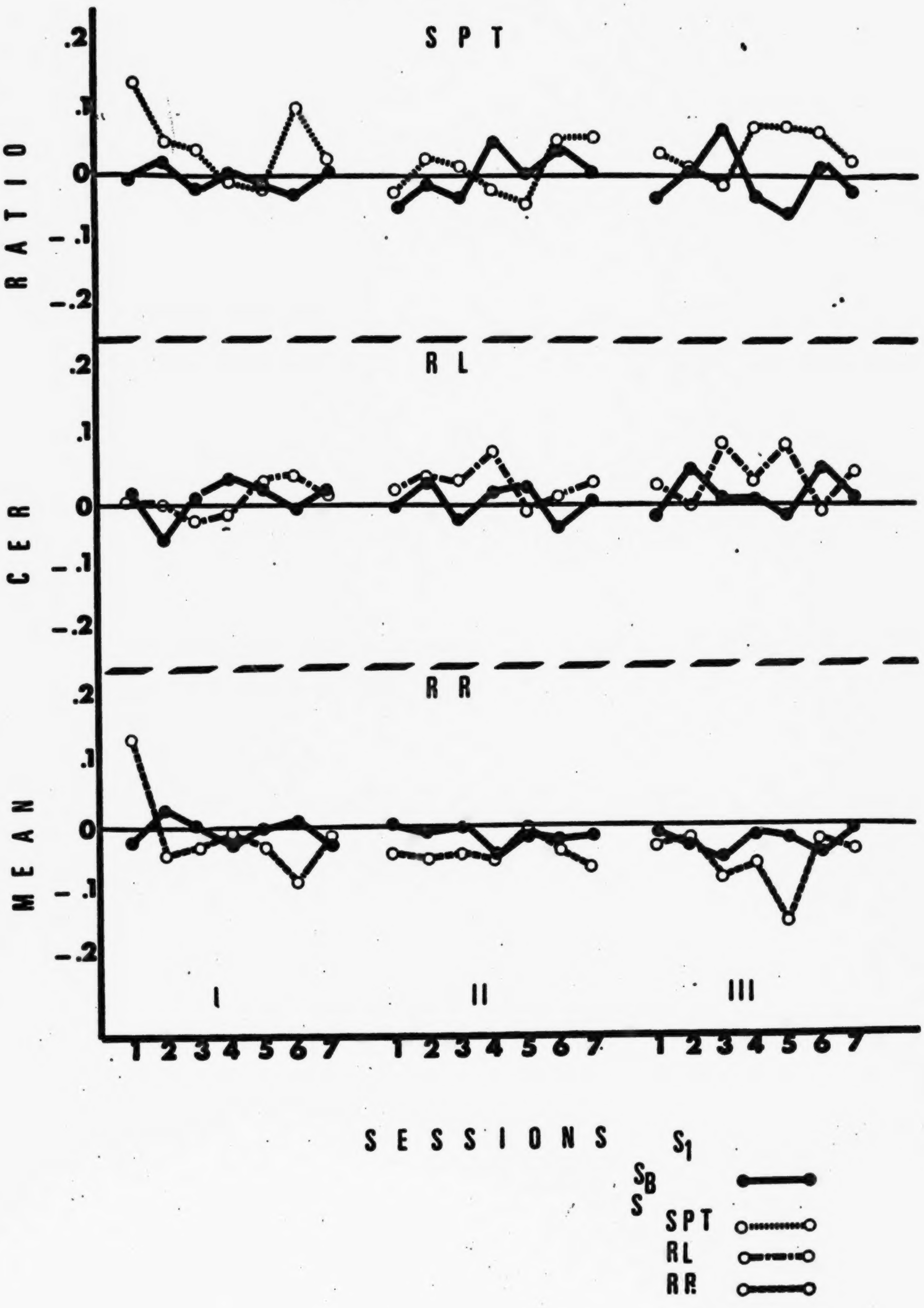

SPT
RL
RR
.2
.1
0
-.1
-.2
MEAN CER RATIO
I
II
III
1 2 3 4 5 6 7
1 2 3 4 5 6 7
1 2 3 4 5 6 7
SESSIONS
S_6
S_B
S
SPT
RL
RR

Fig. 20.--Mean CER ratios for response rate (RR), response latency (RL), and stimulus presentation time (SPT) for S1 for each of the 3 levels of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.)


S P T
R L
R R
RATIO
CER
MEAN
.2
.1
0
-.1
-.2
I
II
III
1 2 3 4 5 6 7
SESSIONS
S_1
S_B
S
SPT
RL
RR

of responding/15-second interval decreased in the interval following CS onset and in the interval preceding UCS onset. As task complexity increased, the magnitude of the decrease during the period immediately following CS onset increased. None of the female Ss (5, 6, or 1) showed the consistent effects that were demonstrated by the males, although S1 did show an increase in response rate following CS onset. A comparison of S1's RR between Shock-baseline and Shock conditions for the 32-stimulus task indicated a higher RR for the last 75" during the Shock condition. Since S1 had no knowledge of the possibility of CS onset prior to 45" the increased RR during the periods 16 - 30", and 31 - 45" must have been due to variability and sampling error.

The conclusions warranted by the data presented in Fig. 21 were that if the individual was to react to the CS, this reaction would be maximum following CS onset and immediately prior to the occurrence of the noxious stimulus. During the interval between CS onset and UCS onset, the behavior of the S was generally not as adversely affected.

Performance Decrements and Anxiety Scales

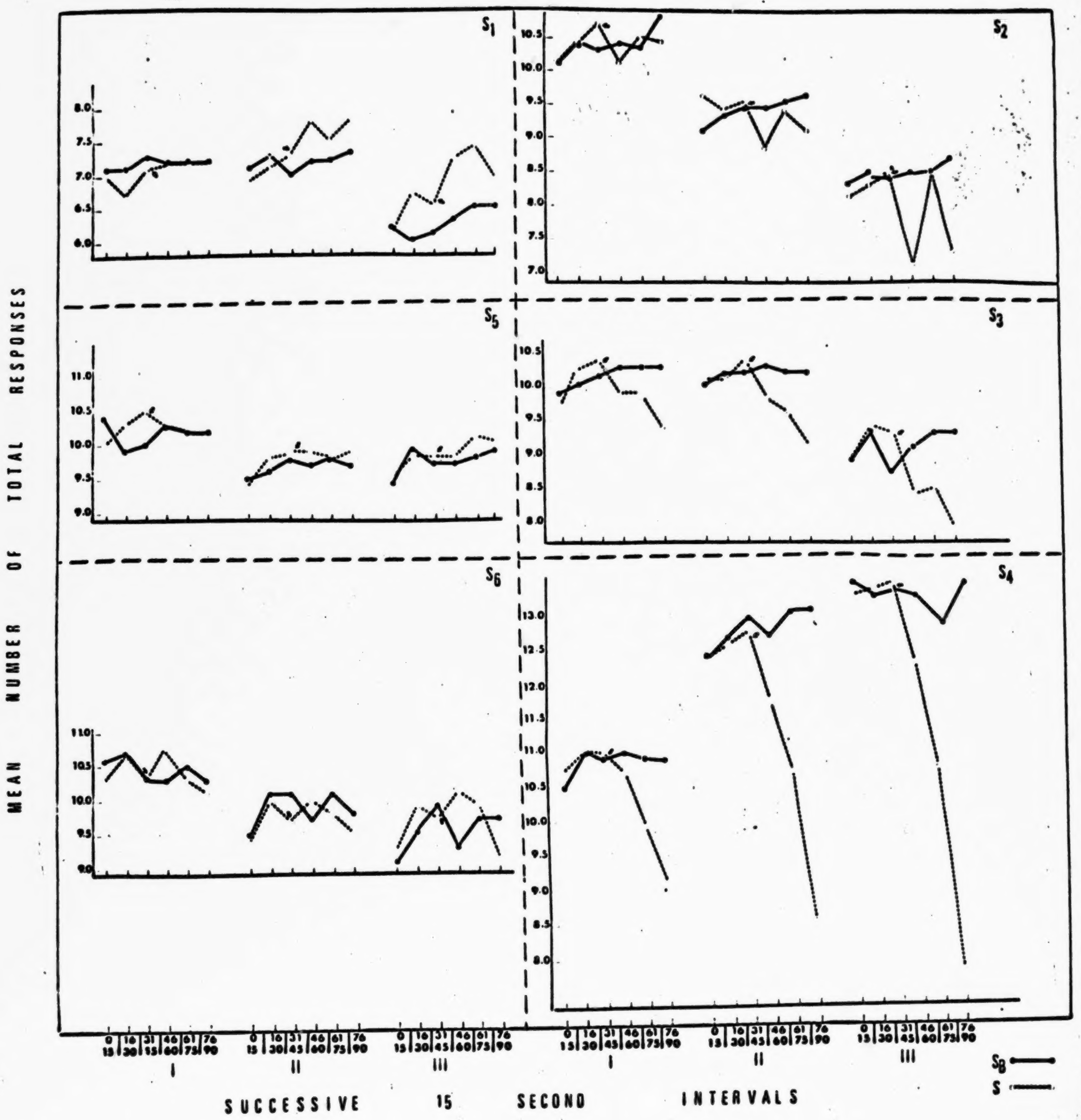
Rankings of Ss according to their scores on the A-trait scale of the Self Analysis Questionnaire, from lowest to highest, were correlated with their rankings with respect to performance decrement from most to least. The obtained correlations, correcting for tied ranks, was $r = .986$. This correlation was significant at $p < .01$. When rankings of Ss based on their A-state scale scores were correlated with their rankings based on performance decrement, the corrected correlation $r = .336$ was not significant.

DISCUSSION

Within the experimental design of the present study, the results indicated that the CER may be obtained using human Ss. However, this response was not as great as might have been anticipated in view of the findings for infrahumans. A number of possibilities exist for this apparent difference.

The theoretical literature has considered the CER as being due to the presence of motor responses which are anticipatory of the noxious stimulus and which interfere with the Ss' performance on the operant task. A possible explanation of the observation that humans do not consistently demonstrate the CER might be that, in the presence of the anticipated noxious stimulus, humans

Fig. 21.--Mean number of responses for successive 15-second intervals during Shock-baseline (S_B) and Shock (S) conditions for each S for each level of task complexity. (Level I = 8-stimulus task, Level II = 16-stimulus task, and Level III = 32-stimulus task.) The arrow at the end of the 31-45" interval indicates the point at which CS onset occurred.


S1
8.0
7.5
7.0
6.5
6.0
S2
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
S5
11.0
10.5
10.0
9.5
9.0
S3
10.5
10.0
9.5
9.0
8.5
8.0
S6
11.0
10.5
10.0
9.5
9.0
S4
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
MEAN NUMBER OF TOTAL RESPONSES
0 15
16 30
31 45
46 60
61 75
76 90
I
II
III
SUCCESSIVE 15 SECOND INTERVALS
S_B
S

may emit verbal or non-task interfering motor behaviors without necessarily producing a disruption of their operant responding.

On termination of the present study the Ss completed a questionnaire designed to find out how they felt when CS onset occurred and what they may have attempted to do during the CS-UCS interval. The question "Did you attempt to do anything different when the noise came on?" was included in an attempt to determine whether or not the Ss emitted any behaviors as a means of coping with the anticipated noxious stimulus. (Coping behaviors were defined as responses S emitted in the presence of the CS for the implied purpose of minimizing the anticipated noxious stimulus.)

In reply to the above question, the Ss stated:

S1: During the tone I would work at a pretty steady rate and count ten changes of the slides. Then I knew that the shock was coming.

S2: Yes. Maintain my composure until the shock was over. Time the length of the sound so as to be able to anticipate the shock.

S3: No, but at times I felt it actually made it easier to select choices. It cleared my mind of other thoughts that might have been present.

S4: I'd slow down, grit my teeth, and wanted to take the wires off.

S5: Yes. Sometimes I'd bite my lip just to cause pain so that the intensity of the shock would not be so bad.

S6: No. I tried to forget about the shock. I'd concentrate on anything else, other than the shock. Daydreaming.

Although all the Ss verbalized feeling anxiety or some other state synonomous with the general concept of anxiety during the CS-UCS interval, such verbalizations do not imply that the behavioral manifestation of the verbalized anxiety will be demonstrated via the CER. The above quotations indicate that the individual Ss attempted to utilize different methods for coping with the impending noxious stimulus. The method of coping of some *Ss* interfered with their performance, while the method of coping of other *Ss* enabled them to anticipate the noxious stimulus without interfering with their performance.

The reported pacing of *S*1, which would decrease her variability of responding, was evident in her data, especially during the 16-stimulus task. This *S* also reported being bored with the task and verbalized that the reinforcement schedule demanded that she only had to respond at a slow rate to receive reinforcement. This last observation may account for her low and variable rate of performance.

The male *Ss* (2, 3, and 4) did not report using behaviors as deliberate as those reported by the females, although *S*2 attempted to time the CS-UCS interval. *S*2 was also the male *S* who demonstrated the least amount of performance decrement. Of the six *Ss*, only *S*4 reported deliberately slowing down as a means of coping with the impending UCS. This is consistent with the observation that *S*4 showed the largest amount of performance decrement.

It may be noted that the *Ss* who had high scores on the A-trait scale utilized a variety of coping mechanisms, whereas those who scored low on the A-trait scale did not attempt to resort to "other" behaviors as a means of controlling the feelings of anxiety that they verbalized. In that A-trait theoretically reflects the "anxiety-proneness" of the *S* (Spielberger, 1966), those *Ss* who are less prone to experience anxiety should, by definition, be less familiar with dealing with and/or accepting the presence of that state referred to as anxiety. It is thus a logical supposition that low A-trait *Ss* would be less familiar and/or adept at coping with anxiety in that they experience and deal with anxiety less frequently. The assumption for these *Ss* is that if their anxiety level is increased, they will not have the repertoire of coping behaviors and thus will not emit non-task interfering behaviors to control anxiety. Rather, they will allow the anxiety to interfere with their task oriented behavior. Possible evidence for this assumption is *S*2's utilization of an "inappropriate" coping behavior which did not serve to reduce his control over the anxiety producing situation, but only served to indicate when the noxious stimulus would occur. Until the delivery of the UCS, *S*2 assumed a passive role in coping, while *S*1, who also attempted to time the interstimulus interval, undertook an active role in this situation.

Preliminary norms for the A-trait scale (which became available to this author after the present data were collected) indicate that A-trait scores for females are slightly higher than for males (Spielberger, Gorsuch, and Lushene, 1968). If this implies that females have a slightly greater predisposition to manifest anxiety, then based on the supposition that "low A-trait Ss would be less familiar and/or adept at coping with anxiety since they experience and deal with anxiety less frequently," it should be expected that females (as a group) should cope with a CER paradigm more efficiently.

Although the term CER is typically associated with conditioned suppression or performance decrement, this may be an unfortunate connotation of the term largely traceable to infrahuman research and to Watson and Rayner's (1920) utilization of this term to describe the behavior of an infant in a fear situation. As indicated by Kanfer (1958a) and Edelman (1965), humans may demonstrate response facilitation in the presence of the CER paradigm. The verbalizations of S1, who worked at a steady rate, and S6, who reported "At times I would go faster to keep it out of my mind," indicate that facilitation may be as much a reaction to the CER paradigm as is response suppression.

The varied types of behavior that Ss emit as a means of coping with the impending UCS illustrates the need to design a task which should be sensitive to emitted behaviors which are not task oriented. It is possible that the inconsistencies reported in CER research with humans may be due to the insensitivity of the behavioral tasks used to various types of non-task oriented behavior. The simple bar press response, as Sachs and May (1967) reported, was totally insensitive to the presence of simultaneously occurring non-task oriented behaviors. Edelman (1965) was slightly more successful in producing change when Ss were required to work with an 8-stimulus matching task. He reported that 20% of his S sample (1 of 5 Ss) demonstrated a performance decrement. In the present study, 50% of the S sample demonstrated performance decrement for the 32-stimulus task. The observation was also made that for those Ss who indicated performance decrement, the amount of decrement increased as task complexity increased.

Although these results provide support for the hypothesis that task complexity is an important variable in CER research, they also indicate the need to use a task which is maximally sensitive to non-task emitted behaviors.

A third possible reason for the different CER findings for humans and infrahumans may be that human Ss (particularly college students) tend to comply with the requirements of the behavioral task for social reinforcement. The effects of social reinforcement on maintaining the behavior of humans in a CER task may be an important factor which related to the smaller performance changes shown by humans. Despite the findings that the performance changes of humans are typically of lesser magnitude than those found with infrahumans, if the performance changes are consistent and clearly distinct from baseline performance, then the effect of the procedures used to produce the change is significantly demonstrated.

The CER ratio, as formulated by Dinc (1965), is relatively insensititve to small, though consistent changes. With human Ss, the use of mean response rates affords a better method of estimating the magnitude of the procedural effect. Each of these methods has a distinct advantage and a disadvantage. The respective advantages are that mean response rate allows for the estimation of magnitude, while CER ratios provide a means for reducing dfiferent response rates to a comparable measure. The disadvantage of the CER ratio is its relative insensitivity to small changes, while the disadvantage of mean response rate data is a lack of comparability for different rates, especially if response rates are markedly different across Ss or within Ss from task to task.

This study poses several implications for future CER research with humans. One implication is the need for a replication utilizing more Ss of both sexes. It may be advisable to select Ss on the basis of A-trait scores, thereby attaining a representative distribution of sexes and anxiety scale scores. Furthermore, the results of the present study indicate that using only the 32-stimulus task would be sufficient.

Another implication is the need to devise a behavioral task which would be sensitive to a variety of non-task oriented behaviors. This would minimize the possibility that Ss could successfully cope with the anticipation of the noxious stimulus. A variation of this idea might be to use children as Ss, since children might not have the elaborate repertoire of coping behaviors present in adults.

In addition, it would be advisable for future research to examine changes in response distribution within the CS-UCS interval. This would allow for the detection of small, though consistent changes in responding.

Lastly, the absence of consistent agreement between verbal and motor behaviors as indicators of the presence of an inferred organismic state (i.e., anxiety) suggests that a further extension of CER research would be to investigate the variables behind the differences between verbal and motor indicants of this "common" state.

SUMMARY

The present study was designed to investigate the effects of increasing levels of task complexity on the conditioned emotional response (CER) with human Ss. The rationale behind considering task complexity as an important variable influencing the CER with humans, was based on Kanfer's (1958,a) third hypothesis, and on a consideration of the studies of Edelman (1965) and Sachs and May (1967).

Based on these studies, three hypotheses were proposed. It was first hypothesized that the CER would increase as task complexity increased. Secondly, it was hypothesized that there would be sex differences between Ss with respect to the interaction between the CER and task complexity. Finally, it was hypothesized that the CER procedures would increase response variability.

Three male and three female Ss participated in matching-to-sample tasks. Each S served as his own control for each of 3 levels of task complexity (8-, 16-, and 32-stimulus tasks). After obtaining a stable baseline level of performance on the 8-stimulus task, each S received 7 sessions of CER training. Conditioned emotional response training consisted of using a 2100 cps tone as the CS and pairing it with a "painful" level of shock (the UCS). The interstimulus interval was 45". After completing 7 CER sessions on the 8-stimulus task, Ss were trained to baseline on the 16-stimulus task. Following baseline, 7 CER sessions were conducted. The same procedures were followed for the 32-stimulus task. Upon completing the 32-stimulus task, each S was administered a 7-question questionnaire and the Self Analysis Questionnaire (Spielberger, 1968).

The dependent variables were rate of responding, stimulus presentation time (time between making a response and presenting the next stimulus), and response latency (time between presenting a stimulus and making a response). Statistical analyses of group data did not support the hypothesis that the CER would increase as task complexity increased. Visual analysis of the performance of individual Ss, when presented in figures, using both means and suppression ratios, indicated that if a S demonstrated the CER, the magnitude of the CER increased as task complexity increased. This relationship was observed to be

more visible for response rate and response latency than for stimulus presentation time.

Statistical analyses of group data did not support the hypothesis that there would be significant sex differences with respect to the interaction between complexity and the CER. The results of these analyses did imply that there was a significant sex difference with respect to the effect of CER procedures, but this was not related to task complexity.

There was no support for the hypothesis that CER procedures affected response variability.

Data were presented which indicated that the effects of the CS on responding was maximal following CS onset and preceding UCS onset.

A significant correlation was obtained between Ss' scores on the A-trait scale of the Self Analysis Questionnaire and Ss' rankings on performance decrement.

The results of this study were discussed with reference to the differences between the magnitude of the CER for humans and infrahumans. Among the possibilities proposed for these differences were the variety of coping behaviors which humans utilize, the insensitivity of tasks which have been used in human CER research to non-task oriented behaviors, and the uncontrolled variable of the Ss' obtaining social reinforcement. The implications of these considerations for future CER research with humans were discussed.

CONDITIONED ANXIETY RESPONSES IN RETARDED CHILDREN

Jack G. May, Jr. and David A. Sachs
Florida State University

In addition to the major portion of this research program, that contained in Mr. Sachs's dissertation, an attempt was made to investigate the conditioned anxiety response in retarded children. The literature is essentially void of research of this nature with children. It was expected, however, that there would be more evidence of response suppression with retarded children than with adults.

METHOD

Subjects:

Subjects were six children enrolled in the Florida State University Psychology Research Class for retarded children. These children were in the trainable range of intelligence.

Apparatus and Procedure:

The apparatus and procedure in this experiment were essentially the same as that in the main study with two exceptions: four- and eight-stimulus tasks were used rather than eight-, sixteen-, and thirty-two-stimulus tasks. Originally it had been planned to use four-, eight-, and sixteen-stimulus tasks, but the sixteen-stimulus task was eliminated because of data from the four- and eight-stimulus tasks.

The UCS for this study consisted of a loud noise generated by a B-29 warning horn that was placed directly in front of the child approximately eight feet from him. This replaced the shock used in the main study.

The third change was in the reinforcement for the instrumental response. Rather than points that had been used in the main study, pennies were dispensed on the same schedule of reinforcement. The pennies were then exchangeable for toys at the end of each session.

RESULTS AND DISCUSSION

In general, the results of this section of the study were somewhat disappointing. The authors feel forced to look upon this as a pilot study in which a number of difficulties were encountered. In view of the difficulties, which will be elaborated upon, the authors prefer not to present specific data since they are not considered to be reliable enough for publication.

While this paradigm is seen as a reasonable one in which to study this phenomenon with retarded children, it is evident that a number of modifications must be made before it produces reliable data. First of all, the task is too complex for some children. Other children, in addition to the six run in the study, were begun but were unable to comprehend the nature of the task. Even those who remained in the study occasionally demonstrated a lack of comprehension and it was difficult to obtain stable rates of responding as well as stable rates of accuracy. It is suggested that a relatively long baseline period be run to establish reliable rates and accuracy of responding before any treatment begins. It was found in this study that, even after reasonably long periods of stable rates, the stability was suddenly lost, particularly after weekends.

It seems that more suitable, dependent variables must be used also. There was no doubt that in some subjects, suppression was established. However, it was established in a way that did not reflect in data. Two of the subjects simply refused to go into the room again. Still another subject ceased responding not only in presence of the CS but in presence of other stimuli in the room. He would go sometimes for a full session without making any response except when the examiner was present and asking him to respond. Thus, it appeared that overgeneralization of the suppression was evident. Since children were subjects and not rats and must be handled with more consideration, the suppression did not reflect in curves.

Finally, it is felt that other stimuli should be chosen since the children seemed to have difficulty in discriminating between stimuli even when only four were used. Furthermore, discrimination tended to break down in the later phases of the experiment even when it was reasonably stable earlier. While it would seem reasonable to expect that the discrimination breakdown may have been a function of anxiety, it was by no means limited to the period of time the CS was on. Rather, the lack of discrimination was evident throughout experimental sessions and was rather variable from one session to the next.

The apparatus and procedure are presently being redesigned in an attempt to eliminate some of the difficulties encountered here. While the data obtained from this portion of the study are not considered to be usable, this study has provided very useful information for the design of another study in which to study this phenomena.

SUMMARY

An attempt was made to study the conditioned anxiety response in retarded children incorporating the apparatus and design similar to that of the major portion of this study. Some changes were made: (1) a loud noise rather than electric shock was used as the unconditioned stimulus, (2) only four- and eight-stimulus tasks were used rather than the eight-, sixteen-, and thirty-two-stimulus tasks, and (3) pennies, that were exchangeable for toys, rather than points, exchangeable for money, were used as a reinforcer.

Numerous problems were encountered in adapting this design to retarded children. In general, the task was too complex and their behavior failed to stabilize. A number of suggestions were made for future research in this area, but the data compiled in this experiment are not considered to be reliable. Some general statements regarding suppression were made. Subjectively, suppression appeared to be evident, but it was evident in a rather generalized fashion rather than during the period of the CS. Some children refused to participate further in the experiment, and others suppressed their responding not only in the presence of the CS, but at times, the CS was not present.

APPENDIX A

Self Analysis Questionnaire
FORM B

Name______________________ Date_______________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you *generally* feel.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

		Almost Never	Some-times	Often	Almost Always
1.	I tire quickly	1	2	3	4
2.	I feel like crying	1	2	3	4
3.	I wish I could be as happy as others seem to be	1	2	3	4
4.	I am losing out on things because I can't make up my mind soon enough	1	2	3	4
5.	If I had my life to live over again, I would want it the same	1	2	3	4
6.	I am "calm, cool, and collected."	1	2	3	4
7.	I feel that difficulties are piling up so that I cannot overcome them.	1	2	3	4
8.	I worry beyond reason over something that really doesn't matter	1	2	3	4
9.	I feel useless	1	2	3	4
10.	I am inclined to take things hard	1	2	3	4

11. Life is a strain for me 1 2 3 4

12. I lack self-confidence. 1 2 3 4

13. I shrink from facing a crisis of difficulty 1 2 3 4

14. I feel blue 1 2 3 4

15. I do (have done) many things which I regret 1 2 3 4

16. I brood 1 2 3 4

17. Some Unimportant thought runs through my mind and bothers me. 1 2 3 4

18. I take disappointments so keenly that I can't put them out of my mind 1 2 3 4

19. I feel tired. 1 2 3 4

20. I get in a state of tension or turmoil as I think over my recent concerns and interests. 1 2 3 4

Self Analysis Questionnaire
FORM B-1

Name________________ Date______________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Reach each statement and then circle the appropriate number to the right of the statement to indicate how you felt when the tone came on.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

		Not at all	Somewhat	Moderately so	Very much so
1.	I am calm	1	2	3	4
2.	I feel secure	1	2	3	4
3.	I worry over possible misfortunes . .	1	2	3	4
4.	I am a steady person.	1	2	3	4
5.	I find myself worrying about something	1	2	3	4
6.	I am easily upset	1	2	3	4
7.	I feel regretful.	1	2	3	4
8.	I feel rested	1	2	3	4
9.	I feel anxious about something or someone.	1	2	3	4
10.	I feel free of guilt.	1	2	3	4
11.	I am "high strung".	1	2	3	4
12.	I feel that I am no good at all . . .	1	2	3	4
13.	I feel I am about to go to pieces . .	1	2	3	4
14.	I feel self-confident	1	2	3	4
15.	I am happy.	1	2	3	4

16. I am content 1 2 3 4

17. I feel worried 1 2 3 4

18. I am over-excited and "rattled". 1 2 3 4

19. I am joyful. 1 2 3 4

20. I feel pleasant. 1 2 3 4

APPENDIX B

QUESTIONNAIRE

1. What do you think was the purpose of this experiment?

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2. How did you feel when the noise came on?

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3. Did you notice any relationship between the noise and the shock?

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4. Did you attempt to do anything different when the noise came on?

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5. Did the noise "bother" you in any way? If so, how?

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6. During the course of this experiment, did you give yourself any instructions that may have influenced your behavior?

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7. At any time during the experiment, did you want to a) stop working for a little while? b) quit the experiment? If so, for what reasons?

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